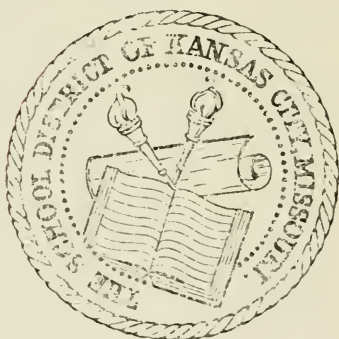


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BELL TELEPHONE QUARTERLY



VOL. XIV

JANUARY, 1935

NO. 1

THE LONG STRUGGLE AGAINST CABLE
CROSSTALK

THE LAST WORD IN TELEPHOTOGRAPHY

PRESENT-DAY HOUSING IN SIXTY-FOUR
AMERICAN CITIES

THE CHANGING YEARS AS SEEN FROM
THE SWITCHBOARD

INTERNATIONAL RADIO TECHNICAL
COMMITTEE MEETING OF
LISBON, 1934

УРАДНИ СЛУЖБ
УТО ЗАНАЈ
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BELL TELEPHONE QUARTERLY

VOLUME XIV, 1935



INFORMATION DEPARTMENT
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York

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*A Medium of Suggestion
and a Record of Progress*

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Thomas A. Watson

1854 - 1934

The Long Struggle Against Cable Crosstalk

IN the year 1935 the Bell System observes the twenty-fifth birthday of loaded quadded toll cable. The anniversary will recall to many of the older telephone engineers a quarter century of struggle against the greatest bugbear of such cable: crosstalk. The tendency for one circuit to repeat its message in an adjacent circuit increases rapidly as the circuits are placed closer together. Since cable circuits are intimately associated both in the cable proper and in the loading coils, the problem of establishing such an electrical balance that crosstalk will not occur is a severe one.

In quadded cable it is especially severe. Each quad is a unit composed of two pairs of wires. Two "side" circuits are operated in each quad, one over each pair. A "phantom" circuit is also operated in each quad, using one pair as the outgoing and the other as the returning path. Between these three circuits crosstalk is particularly difficult to control because the phantom circuit uses the wires of the side circuits and because the two pairs of wires are so close to each other.

History reveals that as early as 1898, three quads were included for experimental purposes in a non-loaded cable which was installed between the John and Franklin central offices in New York City. The crosstalk between the phantoms of these quads and the side circuits was found to be severe. The next experimental attempt to use quads was in 1903, but again unsatisfactory crosstalk results were obtained. Undismayed by these failures, the development engineers resumed the investigation about 1908, when the use of phantom circuits began to look very attractive. While consideration was given to the "spiral-four" type of quad at this time, the multiple-twin type

was chosen as the most promising and it has continued as standard for toll cables in the Bell System.

The multiple-twin quad is formed by twisting together two twisted pairs. This means for reducing crosstalk is similar in principle to the means used on open-wire lines. There the two wires of a pair are "transposed" at regular intervals. By thus interchanging the positions of the two wires relative to those of neighboring lines, the crosstalk currents due to a length of line between two transpositions are made to oppose those from the next length. In the cable, each twist of the wires is analogous to a transposition.

By 1910, a practical multiple-twin quadded cable had been developed, and a loaded cable of this type was installed between Boston and Neponset, a distance of about six miles. While the manufacturing processes used in making this early cable were a vast improvement over the previous processes, the cable as it left the factory was not sufficiently well balanced for commercial operation. Crosstalk between circuits in different quads was minimized by splicing successive lengths of cable in such manner that two quads were adjacent for only a small part of their total length, as is still done today. To reduce crosstalk between circuits in the same quad, "capacitance unbalance test splicing" was devised, and applied in the installation of the cable. By this expedient, crosstalk in one cable length is made to counteract partially the crosstalk in an adjacent cable length. Since 1910, skill in manufacture has further greatly reduced the unbalances in cables, but not enough to do away with capacitance unbalance test splicing in the field, since increases in the length of cable circuits and the advent of telephone repeaters have made it necessary to lower the limits of tolerable crosstalk per unit length of cable.

The general plan of capacitance unbalance test splicing, which was used in 1911 in the original quadded cable installed on the Boston-Washington route, was continued until about 1919. As is still the practice, loading coils were connected in each cir-

THE LONG STRUGGLE AGAINST CABLE CROSSTALK

cuit at regular intervals of about a mile in order to reduce the attenuation of the telephone currents and prevent the conversations from becoming too faint. Seven capacitance unbalance tests were made in each "loading section," or interval between coils. To make these tests, each loading section was divided into eight approximately equal lengths, as indicated in Fig. 1,

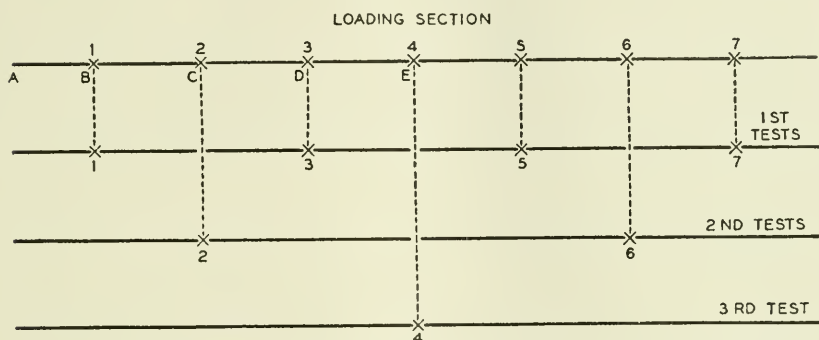


FIG. 1. CAPACITANCE UNBALANCE TEST SPLICES IN A 7-TEST LOADING SECTION.

and splices required within these lengths were made first. Capacitance unbalance tests were then performed at points 1, 3, 5 and 7, with all circuits open at the loading points and at splices 2, 4 and 6. Test 1 was made in such a way as to minimize the unbalanced capacitance in length *AC* of Fig. 1. This was done by splicing together the quads at *B* so as to tend to "neutralize" an unbalance in length *AB* by an opposing unbalance in length *BC*. Tests 3, 5 and 7 were handled in a similar manner. It was also necessary to coördinate Test 1 with Test 3 in order that unbalances of approximately equal magnitude and of opposing relationship would result in the sections *AC* and *CE* which were to be spliced together at splice 2. Similarly, Tests 5 and 7 were coördinated. Tests 2 and 6 were made coördinately upon completion of splices 1, 3, 5 and 7, and finally tests were made at splice 4.

This procedure in greatly modified form survives in present practice. Certain other measures, which were found necessary

during installation of portions of the original Boston-Washington quadded cable, have since been discontinued as the manufacture of cable and of loading coils was improved.

Due to manufacturing difficulties, the first twenty miles of cable manufactured for the Philadelphia-Washington section had unbalances higher than were expected from experience with the Boston-Neponset cable. It was decided, therefore, to place this 20-mile length in the middle of the cable, between Wilmington and Baltimore. In this way, the crosstalk of the 20-mile section became relatively unimportant because of the large transmission loss of the speech in going from either terminal out to the 20-mile section and of the crosstalk in returning to the originating terminal.

Allocation of the loading coils, similar to that of the cable, was also resorted to on the Philadelphia-Washington cable. Furthermore, capacitance unbalance measurements were made on the stub cables of the loading coils in the section from Havre de Grace to Washington. The loading coils were then connected to the section of cable in such manner that the unbalances in the main cable tended to neutralize the stub-cable unbalances. The high stub-cable unbalances on this project were due to the use of textile-insulated stub cables. Changing to a paper-insulated type caused so large an improvement in the unbalances that matching of coil stubs against cable could be discontinued.

The World War greatly increased the demand for additional toll circuits, particularly along the eastern seaboard, and relief cables were required in certain sections. Most materials were scarce at that time, and core materials for loading coils were no exception. Since the core material required for a side-circuit coil at that time was roughly half that required for a phantom coil, it was decided to load only the side circuits in such relief cables, and not to use the phantom circuits. In this way, an amount of core material which previously served three circuits could be made to serve four.

THE LONG STRUGGLE AGAINST CABLE CROSSTALK

When core materials became more readily available, loading coils were installed on these cables for the phantom circuits also. Normally the three coils required for the phantom and side circuits of each quad in a cable are potted together in the factory, to form a "phantom loading unit." Before the sealing compound is flowed into the pot, suitable measures are taken to minimize the crosstalk caused by all these coils in the three circuits. In the case of the relief cables, whose side circuit coils were already potted separately, crosstalk between the phantom and side circuits had to be reduced by measures taken during installation. The procedure of crosstalk "poling" was adopted. This was somewhat like the method which would have been used in the factory, if these phantom and side circuit coils had been potted together. At each loading point the magnitudes of the crosstalk within each quad were measured for all the pairs of side circuit coils and all of the phantom circuit coils. These measurements formed a basis for selecting the phantom circuit coil to be used with each pair of side circuit coils. The crosstalk within each phantom loading unit was then measured with the phantom coil connected to the pair of side coils in each of the eight possible ways that two quads can be connected together. The eight different ways of connection were readily obtained by the use of a "transposition switch" inserted between the phantom coil and the side circuit coils. Each group of coils was finally spliced in accordance with the transposition giving the minimum resultant crosstalk.

As cable design and manufacturing processes were improved, the capacitance unbalances per reel length of cable were gradually reduced. By about 1919, it was found permissible to standardize a three-test plan of capacitance unbalance testing in place of the seven-test plan: in other words, tests at splices 1, 3, 5 and 7 of Fig. 1 were discontinued. This effected a considerable reduction in the cost of field testing.

The original toll cable circuits were operated without repeaters and the attenuation or weakening of the conversations

was offset as far as practicable by using large wires (No. 10 and No. 13 gauge) and large loading coils. The overall attenuation in these circuits was large, however, as compared with modern standards, and the conversations were relatively faint. The development of amplifying repeaters made it practicable to reduce the overall attenuation greatly, and at the same time to reduce the wire sizes to 16-gauge and 19-gauge, but the reduced attenuation made the crosstalk problem more difficult, for the unwanted crosstalk currents were amplified along with the currents carrying the wanted conversation. Nevertheless, the system of three test splices per loading section, together with crosstalk corrective work performed on the loading coils in the factory, gave satisfactory results until 1922.

At about that time small-gauge toll cables began to receive "extra-light" loading, involving considerably smaller coils than formerly used. This made it possible to extend toll cable circuits to much greater distances without distorting the speech sounds, and to further reduce the over-all attenuation. The longer lengths and lower attenuations increased the difficulty with crosstalk. Furthermore, the nature of these extra-light loaded circuits introduced the very difficult problem of even further improving the loading coils against crosstalk. Without such improvement it appeared that crosstalk in the loading coils would contribute the major part of the total crosstalk in the projected long circuits, and development work was directed towards reducing the crosstalk from this source. While development work on the loading coils was under way a return to the seven-test capacitance unbalance plan was considered as a temporary expedient for reducing crosstalk in the field. Manufacturing improvements, however, had produced cable whose unbalances were comparatively small, and the seven-test plan could not be economically justified by the slight crosstalk reduction which might have been obtained. It was decided to use a system of crosstalk poling for one or more sections of cable and associated loading coils. In general, this method was

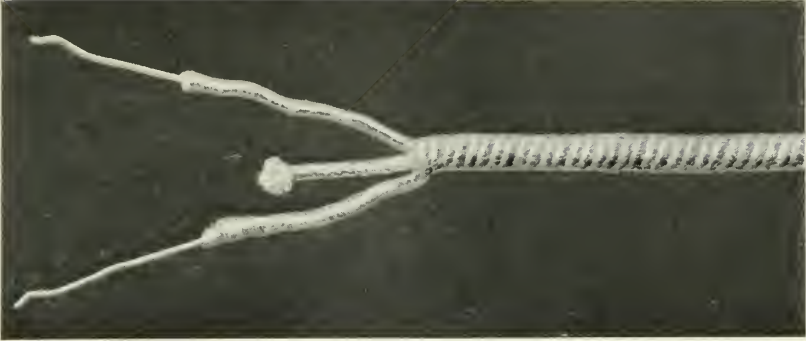


FIG. 2. BALANCING CONDENSER UNIT CONSISTING OF A PAIR OF WIRES WOUND HELICALLY AROUND A TEXTILE CORD.

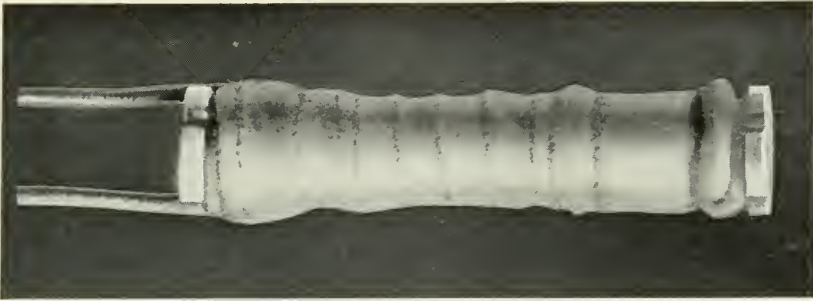


FIG. 3. BALANCING CONDENSER CONSISTING OF A PAIR OF WIRES WOUND ON AN ISOLANTITE SPOOL.



FIG. 4. A SPLICE IN WHICH BALANCING UNITS ARE BEING INSTALLED. FOR ILLUSTRATIVE PURPOSES, THE PHOTOGRAPH WAS MADE BEFORE THE UNITS HAD BEEN COMPLETELY COVERED WITH COTTON SLEEVES.

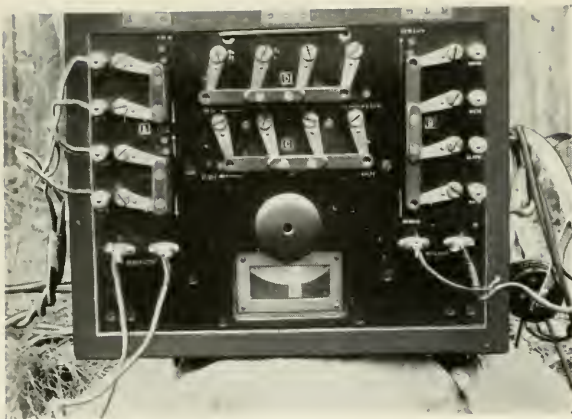


FIG. 5. A 1910
MODEL TESTING SET
USED IN CAPACITANCE
UNBALANCE TEST SPLIC-
ING.

FIG. 6. THE PRESENT
MODEL OF TESTING SET
USED IN CAPACITANCE
UNBALANCE TEST SPLIC-
ING.

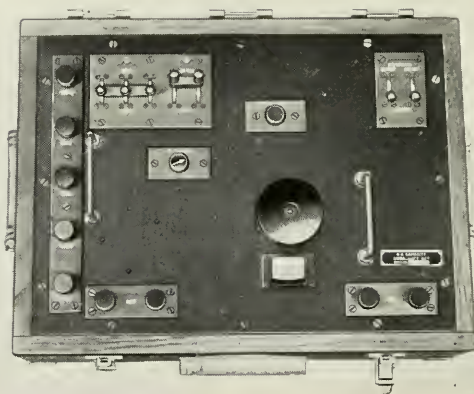


FIG. 7. SPLICING IN
PROGRESS AT CAPACI-
TANCE UNBALANCE TEST
SPLICE ON A BURIED
CABLE.

FIG. 8. (RIGHT.) A TEST SPLICE ABOVE THE JUNIATA RIVER. THE SPLICE IS BEING MADE IN THE TENT AT THE LEFT; THE TESTER WITH HIS APPARATUS IS ON THE PLATFORM AT THE RIGHT.



FIG. 9. (BELOW.) A TESTER WORKING OUT SPLICING INSTRUCTIONS ON A MILD WINTER DAY. CAPACITANCE UNBALANCE TESTING IS PERFORMED IN ALL WINDS AND WEATHERS.





FIG. 10. A LOADING POINT ON TOLL CABLE. THE LOADING COILS CONTAINED IN THE TWO MIDDLE CASES HAVE BEEN CONNECTED INTO THE CABLE. THE PROCESS OF RAISING CASES TO THE LOADING FIXTURE IS ALSO SHOWN. THE RECTANGULAR CASES ARE MODERN PRESSED STEEL CASES; THE CYLINDRICAL CASE IS OF THE OLDER CAST-IRON TYPE.



FIG. 11. CROSS-TALK POLING TEST ON UNDERGROUND CABLE. IN THE RIGHT FOREGROUND IS THE POLING SET WITH TRANSPOSITION SWITCH, ETC.

similar to that which had been used to reduce crosstalk in loading coils on the relief cables. The number of poling tests required was gradually reduced, as progress was made in the difficult task of meeting the extremely severe requirements for balance of loading coils, and poling was entirely discontinued in 1927.

During all this period it had remained necessary to continue making three test splices within each loading section to reduce the crosstalk occurring within the cable, apart from that occasioned by the coils. In 1929 it became evident that it would be economical to spend less time on the test splicing, and supplement it by connecting small balancing condensers between the wires of some of the quads at some of the splices.

The two wires of each pair of a quad have capacitances to any other conductor in the cable. If the quad were perfectly formed, these two capacitances would be equal. In an actual quad these pairs of capacitances are not quite equal, due to inevitable irregularities in the size, insulation, spacing and twisting of the wires. These capacitance inequalities cause the capacitance unbalances which, if not neutralized, would cause most of the crosstalk between the circuits of a loaded quad. A capacitance unbalance can always be represented by a single capacitance, of one value or another, between a wire of one side-circuit and a wire of the other. The two side circuits could be balanced by connecting a condenser, with the same capacitance as that representing the unbalance, between the *same* wire of one side circuit and the *other* wire of the other side circuit. But, in general, such a procedure would not balance the two side circuits to the phantom circuit. All three circuits can be balanced, however, by connecting not one but three condensers of appropriate values between appropriate wires of the quad.

A remarkably simple balancing condenser has been designed, which is inexpensive, occupies only a small space in the splice, and can readily be adjusted in the field to give the desired

small capacitance. This unit, shown in Fig. 2, is made by wrapping two parallel insulated 22-gauge wires helically around a textile cord. Designed to have a balancing capacitance of about five micro-microfarads per inch, the unit can easily be cut by the installer to the length which will give the desired balancing action. Its capacitance to other wires and the cable sheath tends to be small, and is made negligible by covering each installed unit with a cotton sleeve in order to separate it from other conductors. Under these conditions it is very simple to determine, from a measurement of the three unbalances between the circuits of a quad, a set of three balancing capacitances which will reduce the three unbalances to zero. Three balancing units may then be cut to the right lengths and connected between the proper wires of the quad.

The circuits in quadded cable are operated in two different ways, depending upon the circuit length. In "two-wire" operation, which is used for the shorter circuits, transmission takes place in both directions over each circuit; in "four-wire" operation, used with the longer circuits, each circuit is used for transmission in only one direction. At present two different procedures are used for balancing the crosstalk in cable, according to the relative proportion of the circuits which are operated in these different ways.

Most of the toll cables installed in recent years have had only a small proportion of the circuits operated on a "two-wire" basis. For such cables only one test splice per loading section need be made. At this splice, any excessive unbalances on the two-wire quads, which remain after test splicing, are corrected by means of the little balancing units. The test splicing on the four-wire quads is confined to the reduction of phantom-to-side unbalances alone. After the loading coils have been installed, crosstalk measurements are made on the four-wire quads over the complete repeater section. If the crosstalk is still excessive on some of the quads, it is brought within

satisfactory bounds by the installation of balancing condensers at one end of the repeater section.

Since the terminal balancing capacitances required may be fairly large, it is not practicable to obtain them by using units such as shown in Fig. 2 because the required length makes installation difficult. For this purpose the balancing condensers shown in Fig 3 have been standardized. On a small Isolantite spool (about $1\frac{3}{4}$ inches long) are wound two parallel 30-gauge cotton-covered wires, and the whole is impregnated in paraffin to exclude moisture. It is adjusted to the required capacitance in the field by unwinding and removing a portion of the wire from the outer part of the spool. As in the units of Fig. 2, the external capacitances are kept small by covering each condenser with a cotton sleeve.

In dealing with crosstalk it is important to distinguish two types; far-end and near-end. If a listener at New York on one circuit heard crosstalk resulting from a talker at Chicago on another circuit, he would be hearing the crosstalk over a far-end path. If the New York listener heard crosstalk resulting from someone at New York who was talking to Chicago on the other circuit, he would be hearing the cross talk over a near-end path. Near-end crosstalk between four-wire circuits is kept satisfactorily low by placing all circuits transmitting in one direction in one portion of the cable, such as the center, and all those transmitting in the opposite direction in another portion, such as the outer layers. It is to reduce far-end crosstalk that the balancing condensers are installed at the ends of repeater sections.

For cables in which a large proportion of the circuits are of the two-wire type, a single test-splice per loading section has been found impracticable because too many balancing units would be required at the splice. Furthermore, the nature of two-wire circuits makes crosstalk balancing at the offices impracticable. The three-test plan of splicing must be continued, therefore, although balancing units might be used as an alterna-

tive to coördinating the tests at splices 2 and 6. Without coördination only a small percentage of quads would have excessive unbalances at the final test splice and these could be corrected there with the balancing unit.

Twenty-five years of improvement in cable, loading coils, and methods of balancing have made it possible to reduce the unbalance testing in the field far below that required on the first Philadelphia-Washington cable. Methods have been found whereby additional work at the factory or at the repeater stations can be substituted for much of the outdoor testing previously required. Probably these developments can be appreciated best by those men who, like the writer, have performed capacitance unbalance tests in all winds and weathers; when the temperature was below zero, and when it was above 100 degrees. Everyone should appreciate, however, that crosstalk conditions today between telephone circuits in modern cables are very much better than those prevailing a quarter century ago and that developments in crosstalk reduction are keeping in step with the ever increasing length of toll cable circuits.

M. A. WEAVER

The Last Word in Telephotography

UNDERLYING all the electrical arts of communication—and these include not only telegraphy and telephony but also telephotography, television and sound pictures—are a few basic principles. To appreciate those fundamentals is to possess a pass key which opens to ready understanding systems of communication which at first thought appear to have no essential in common. Whether the transmission medium is wire or wireless, whether the signals which convey the information are audible or visual, there is a unity to all the communication arts. However different their devices and contrivances may seem to be, all of them are merely means for performing one or another of six typical operations. Four of these operations are essential to any system of communication and the other two to all except the simplest systems.

The four necessary functions of the parts in any system for communication are most obvious. First, if intelligence is to be conveyed from one place to another there must be a generation of some effect which can be transmitted. Then, this something which can be transmitted must be varied so as to embody in its variations the intelligence which is to be transferred. The current, in other words, which has been generated must be modulated in accordance with the signal, or speech, which is to be transmitted. The next function is transmission; and the final one, the detection of the intelligence—an operation the inverse of modulation which is, therefore, called demodulation.

If at any point along the route of transmission the effect would be too feeble for easy recognition it must be amplified. The operation of amplification, although not involved in the simplest of systems, is of importance in most practical systems.

Similarly of practical importance is the sixth and last of the

functional operations, that of selection. Whenever the medium through which transmission is to occur carries simultaneously more than one stream of intelligence, then selection is necessary at the receiving terminal. In radio, since all communication is through a common medium, and in wire whenever multi-channel transmission is desired, each stream of intelligence is carried by a distinctive current. Each stream arises from an individual generator the output of which is modulated by the particular signal or speech it is to carry. The separate streams can be selected one from the other by virtue of the distinctive characteristics of their respective "carrier" currents.

Generation, modulation, transmission, selection, demodulation, and amplification—these describe all the operations essential to any electrical system for the communication of intelligence. When analyzed for these functions, the simple circuit of an electric bell, with its battery and push button, and a very complex system like that for the simultaneous transmission over a single pair of wires of a score of telegraph messages and three or more telephonic conversations, display common qualities. It makes no difference, so far as concerns the types of operation which are required, whether the signal is audible or visual, whether it is conversation or image which is to be transmitted. An illustration of this fact is to be found in the system for the transmission of pictures which Bell Telephone Laboratories has recently developed.

Before that very interesting and ingenious system is described, the unity of principle which runs through the communication arts may well be traced through telegraphy and telephony, both by wire and by radio.

In the telegraph circuit of Morse a battery was the generator of a direct, that is, zero-frequency, current which was modulated at a low rate by the hand operation of a telegraph key. An electromagnet, as a sounder, detected the variations which the key introduced in the current. In the telephone circuit of

Bell a similar zero-frequency current was modulated, but at the higher rate which corresponded to the pitches of the sound waves of air which were impressed upon the diaphragm of the transmitter. At the receiving end of the telephone circuit the electromagnet, instead of reproducing the motion of a key, reproduced by its diaphragm the vibrations of the transmitter diaphragm and thus established waves in the adjacent air similar to those at the sending station. Both inventors, it is to be noted, employed a zero-frequency current, one to modulate it with a frequency of a few cycles a second, or even less, and the other with a band of frequencies corresponding to the tones of the voice.

Communication systems, however, are not limited to the use of zero-frequency currents. A method for producing high-frequency currents was developed by Hertz and employed by him in his discovery of electromagnetic waves. He also developed a method for the detection of such waves. Their utilization in radio telegraphy followed the inventions of Marconi. Equipment is arranged so that a high-frequency current is produced under the control of a telegraph key; the current, in other words, undergoes modulation at the low frequency of hand operation. When the modulated current flows in an antenna, electromagnetic disturbances occur in the surrounding space and radiate to distant antennas, where they establish similar currents.

Almost immediately the possibility of radio telephony became apparent, but it was not to be successfully accomplished over considerable distances until 1915, at which time Bell telephone engineers demonstrated the system they had developed by radio telephone transmission from Washington, D. C., to Paris. An essential in that system was the operation of amplification. A small current of high frequency was generated; this was modulated at audible frequencies by the current from an ordinary telephone transmitter; and the result of that modulation, amplified to the proper power, was then

fed to the transmitting antenna. For transmission through space, high-frequency currents were required; for guided transmission over wires, low or even zero-frequency currents sufficed. Either type of current could be modulated at either the low frequency of telegraphy or at the higher frequency corresponding to audible tone.

When transmission was unguided, as in radio, selection was necessary at the receiving terminal in order to pick out from the multi-channel ether the radiation from a particular station. The criterion of selection was the frequency (or, from another point of view, the wave length) of the high-frequency disturbance which carried in its modulation the intelligence which was being transmitted.

All these functional operations, from generation to selection, are involved in the latest picture-transmitting equipment designed by Bell Telephone Laboratories. In the transmitting equipment, a narrow beam of light falls on the picture which is to be sent, and the latter moves continuously so that the beam scans successively all the tiny areas which compose it. From the picture the beam is reflected into a photoelectric cell. The reflected light varies in amount from instant to instant, according to the relative light or shade of the elemental areas of the picture upon which the beam falls.

In this part of the system one meets again the essential operation of generation, in this case, the production of a light; of modulation, in this case, at the relatively low frequency at which successive areas are scanned; of transmission, across only a few millimeters of space, it is true; and then, in the photoelectric cell, demodulation, or translation, whereby there is produced in the cell a current with variations of intensity identical with those of the reflected beam. The cell detects the light variations and gives rise to corresponding current variations. What it receives as light it translates into a current which can proceed along wires.

Before the current so proceeds, however, amplification is introduced. This is necessary because the current variations produced by the photoelectric cell are so small that they could easily be obscured by any interfering currents which the circuit might pick up inductively. Before the message-bearing currents of the cell start on their long journey they are made superior, by amplification, to the contaminating influences of neighboring circuits.

The amplified current then proceeds along the line to the distant terminal. In the receiving apparatus at that point one meets again the familiar elements of a communication system. There is, first, a generator for a beam of light. This beam, after transmission through a few millimeters of space, falls as a tiny spot of light upon an unexposed photographic film. Before it reaches the film, however, it is modulated, or varied, so as to involve in its varying intensity the intelligence which is to be conveyed. This modulation is accomplished by the current from the distant sending apparatus. A delicate shutter, electro-magnetically controlled by the current, and intervening between light source and film, varies the light in accordance with the variations of current. What reaches the film, therefore, is a beam of light modulated to correspond to the light and shade in successive areas in the original picture. The process of demodulation is accomplished chemically in the film emulsion. There the actinic action, at each instant, corresponds in amount to the light intensity of the beam. In effect, the intelligence, which is embodied in a varied light beam, is translated into a chemical medium. The final detection of the intelligence awaits the chemical development of the film.

The film, which is being exposed at the receiving station, and the picture, which is being scanned at the transmitting station, must, of course, be moved in precise synchronism. How that is accomplished is not a necessary part of the present story. It is obvious, however, that—although it may require considerable ingenuity to accomplish it—all that is required is that

the motors which drive respectively the picture and the film shall run at identical speeds and start at the same instant.

Of particular interest in this method for transmitting pictures is the number of times translations of intelligence occur; that is, the number of media through which transmission takes place. The original intelligence resides in the pattern of light-reflecting powers which the picture displays. Transmission in the first instant is by light waves and these are modulated in accordance with this pattern. The demodulation which then occurs is not one which makes the pattern immediately intelligible to a human eye but is a translation from the medium of light to that of an electric current. Transmission is next by wire, at the end of which a new modulation is accomplished, translating the intelligence from current to light. The final step of demodulation involves the translation of the light variations into corresponding chemical variations of the surface of the film. The pattern of light-reflecting, or light-transmitting, powers thus established on the film is intelligible to the human eye in the same way, and produces the same effect, as the original picture.

Such, in simple terms, is a description of the newly developed system for transmitting pictures; but that description has passed lightly over a further and more interesting illustration of the general principles which this article would emphasize. In the previous description, nothing was said about the character of the light beam which is generated for scanning the picture. By implication it was a steady beam of light; actually such is not the case. What sort of a beam it is, and why, will now be explained.

The picture, which must not be larger than 11 x 17 inches, is mounted on a drum 12 inches in circumference and 17 inches long. It is driven by a screw with twenty-five threads to the inch through a four-to-one gear, so that the drum turns a hundred times while progressing one inch axially. It moves this inch in one minute. Seventeen minutes are thus required

for scanning the maximum size of picture. A beam of light from a stationary source falls upon the picture in a spot about one-hundredth of an inch square, and scans it in a series of adjacent lines one-hundredth of an inch wide. The smallest area, as to the light and shade of which the photoelectric cell can report to the distant receiving station, is one-ten thousandth square inch.

Imagine in any picture—what might be true—that successive areas of this size, which the beam scans, are alternately light and dark. Then the reflected light will pass through alternate maxima and minima, with one cycle for each two adjacent elementary areas; and similarly will the current in the photoelectric cell. This is the most rapid variation which is possible; and its frequency is half the number of elemental areas which the beam scans in one second. Because the beam scans twelve square inches each minute, each containing 10,000 elemental areas, it covers 120,000 of them in a minute, or 2000 in a second. Hence, the highest possible frequency for the current is one thousand cycles per second.

That is the maximum frequency. The minimum frequency which would exist when the picture was uniform in tone can be computed as follows: The largest picture can occupy eleven-twelfths of the drum, the remainder is allowed for clamps to hold the picture. The light beam scans a line eleven inches long before it falls on the clamps. For $11/20$ second it scans the picture and for the next $1/20$ second it falls on the clamps. In $12/20$ of a second, therefore, the reflected beam would pass through a cycle of maximum and minimum intensity. That means a frequency of a little less than two cycles per second.

The ordinary picture involves all conditions between these two extremes, and so may introduce modulation at any frequency from almost zero to 1000 cycles per second. It is difficult, however, to transmit all frequencies of that band with the same efficiency; but it must be done if the light and shade

of the picture are to be faithfully reproduced at the receiving station.

Now it happens that the frequencies which a telephone line ordinarily transmits, without undue discrimination, lie in a range from about 200 to 2800. That meets the requirements of intelligibility and naturalness. If the thousand cycle band required by a picture extended not from zero to 1000 but from 1400-2400 its transmission could be easily and adequately accomplished by a properly equipped telephone circuit. The designers, therefore, arranged that the band of frequencies, which represents the variations in light and shade of the picture, should be transmitted as a band extending from 1400-2400.

In earlier telephoto equipment, which the Bell System put into service about 1925, this was accomplished by the method of carrier-current operation, using a high frequency for the carrier and modulating it with the current from the photo-electric cell. As will be recognized from the previous discussion, this is similar to the method of radio telephony where a high-frequency current is modulated by the audio-frequency current from a transmitter. Instead, however, of doing it this way, the designers of this particular apparatus arranged that the high frequency effect which was to be modulated should be introduced in the optical part of the transmitting system, that is, into the light which falls upon the picture.

Before the light reaches the picture it passes through an electromagnetically-controlled shutter. The shutter, or light valve, as it is called, is formed by a fine wire in a magnetic field. When current flows, the wire moves sidewise, cutting off more or less of the light from the lamp. Current of 2400 cycles per second is supplied to the wire from an oscillator of the vacuum-tube type. The valve, therefore, oscillates at the same frequency and produces corresponding variations in the intensity of the light which passes through it. When this

beam falls upon the picture it is modulated in conformity with the light and shade of successive elementary areas.

The current from the photoelectric cell follows exactly the variations in intensity of the light beam. The current, therefore, is an alternating one of 2400 cycles per second, and its strength undergoes variations at the lower rate at which the details of the picture are scanned. There is, however, another way of considering this current—and there is simple trigonometry in substantiation of it. It may be resolved into, and hence considered to be composed of, three components. One of these is a current of steady strength and frequency 2400 cycles. The other components are, respectively, higher and lower than that frequency, and vary in strength in accordance with the light and shade of the picture. The frequency of one of these components is above 2400 cycles by a number of cycles corresponding, at any instant, to the frequency introduced by scanning successive areas of the picture. The other component has a frequency correspondingly below 2400 cycles. Since all frequencies which the picture elements can introduce lie between zero and 1000 cycles the “side band” currents, which have just been described, will have frequencies in the ranges 2400–3400 and 1400–2400 respectively.

The intelligence, or signal, which is to be conveyed from the picture is involved in these three components of the modulated carrier current. For its interpretation, however, both side bands are not necessary. One side band and the carrier are sufficient. In the system under description, therefore, only the lower side band is transmitted. This is accomplished by introducing into the circuit, immediately following the photoelectric cell, an electrical filter which allows to pass only currents whose frequencies lie in the band 1200–2600.

The carrier current and its lower side band then proceed to the receiving station. Amplification is introduced as necessary along the route. At the receiving station this current is demodulated, giving rise to a current, of frequency zero to one

thousand cycles, which is proportional at each instant to the light and shade of an element of the distant picture. This current operates a light valve, similar to that which is used at the sending station, which is interposed between a steady lamp and an unexposed film. Through its action the amount of light which falls on the film is varied from instant to instant in accordance with the light and shade of a corresponding area of the original picture.

From the standpoint of practical engineering there are many advantages to this recently developed system. It is also interesting because it illustrates so completely, and in such a variety of ways, the fact that all systems of electrical communication are constructed around six fundamental operations of generation, modulation, transmission, demodulation, amplification and selection.

JOHN MILLS

Present-Day Housing in Sixty-four American Cities

HOUSING in the United States is at the present time a subject to which the public press is devoting a great amount of space. Adequate housing for all is a social ideal towards the realization of which both public and private agencies are exerting much effort. In so far as the attainment of the ideal involves slum clearance, some notable steps have already been taken. Moreover, a revival of home building sufficiently great to meet the stored-up demand of the depression years is widely regarded as an essential stimulus to the recovery of industry. In view of the subject's interest and importance, the facts revealed by the preliminary reports of the Real Property Inventory made during 1934 in 64 cities* throughout the country are not only timely but also provide data exceedingly useful in appraising present housing conditions and future possibilities. They also present a picture of contemporary American living conditions of considerable social significance.

The Real Property Inventory in these 64 cities was undertaken early in 1934 as a Civil Works Administration project, conducted by the Bureau of Foreign and Domestic Commerce. It covered all residential properties exclusive of hotels, rooming houses, clubs, and summer cottages; and statistics were collected on a variety of items, including the type, material and condition of all structures, the installed household equipment in dwelling units, rentals and property values, the distribution of families in living quarters, etc. Each of the 48 states was represented in the Inventory by at least one city, and an effort was made to have the cities chosen include typical industrial,

* These cities are listed at the end of this article, on page 40.

commercial, and resort communities and show considerable diversity in point of size. The cities range in population from 11,000 to 900,000, and the 64 communities include 33 where the inquiries were made only within the city limits and 31 so-called metropolitan areas, in which the surrounding suburbs were included. (In addition to this group of cities where the surveys were conducted wholly under the supervision of the Bureau of Foreign and Domestic Commerce, a number of other large cities were studied, partly on the same basis and partly as a local undertaking. New York, Philadelphia, Pittsburgh, Detroit, Chicago, Buffalo and the New Jersey cities in New York's metropolitan area are among them, and in some of these cases at least, non-residential properties were included in the Inventory. Only fragmentary results of these surveys are as yet available. A survey made in Cleveland in 1932 served as an experiment from which were developed the methods used in the 1934 studies.)

The particular purpose of the surveys, to obtain information on the condition of urban housing in the United States, makes the results not exactly comparable with other enumerations covering some of the same facts included in the Inventory, as, for example, the 1930 Federal Census of Population, where an accurate count of the population was the first consideration. Moreover, the environs included in the metropolitan areas, though they might perhaps be assumed to correspond with the "Metropolitan Districts" of the 1930 Census, are not defined or described in the preliminary reports of the Inventory; consequently any attempts at comparison with the Census must be limited to the 33 cities for which the data are on a geographical basis known to be the same at the two dates.

From the data on these 64 cities, whose limits contained nearly 8,000,000 inhabitants in 1930 and in which some 2,600,000 dwelling quarters have been enumerated, one can get a picture of what may be considered representative conditions in American urban communities. Some of the facts bear out

the popular conception of our living standards, while others indicate rather startling deficiencies in certain directions. If we were to imagine that a typical city could be described by the medians of the many items covered for these 64 communities, we should find it to be a city of about 75,000 population, where more than two-thirds of the dwelling units are in single-family houses, where over 40 per cent of the occupied units have resident owners and where the average home has five rooms. More than one-third of the residential structures have been built since the war, and about 85 per cent of them are made of wood. With respect to the usual equipment, we should find less than 8 per cent without running water, but nearly 20 per cent with no private indoor toilet facilities and more than one-fourth with no bathtub or shower. About six per cent are lighted by some means other than gas or electricity, and nearly 25 per cent are not equipped to cook by either gas or electricity. Over half have no central heating system. Nearly 25 per cent of the dwelling units have had their present occupants more than ten years, while over 30 per cent have had their present tenants less than a year. In each 100 occupied dwellings there are seven families living "doubled up" with the usual occupants, and seven per cent of the total dwelling units are vacant. There are 55 automobiles for each 100 occupied dwellings, and 16 per cent of the total number of living quarters are equipped for mechanical refrigeration. Individual cities of course vary widely from this composite median community, in some respects because of differences due to climatic conditions, in others because of the variation in age, and in still others because of the marked differences in their average standards of living. It is these last variations which are of the greatest interest.

In general, the published facts may be divided into three groups: (1) those dealing with the structures and their condition; (2) those describing the household equipment, mainly that permanently installed; (3) those dealing with general liv-

ing conditions and factors which indicate spending ability and tendencies. Table I shows the median percentages for a number of the items on which information was gathered and also shows the extremes of high and low percentages and the communities in which they occur.

STRUCTURES

The tendency towards the erection of apartment house structures in urban communities either because of high land values or because of a desire for smaller living quarters has not yet resulted, in these cities, in a condition where multi-family structures house a majority of the families. The highest percentage of dwelling units in multi-family structures in any of these cities occurs in Waterbury, Conn., where 51.6 per cent of the living quarters are in buildings with three or more dwelling units; but of these units more than half are in three-family houses and less than one-third come within the class called "apartments." In only seven of the 64 cities are more than one-third of the dwelling units located in other than one- or two-family houses; and in only 15 cities, 11 of which are in the Northeast area, do two-family houses contain 25 per cent or more of the total number of living quarters. The median percentage of dwelling units in single houses is 67.5. Outside of our largest metropolitan areas, then, American families in urban communities seem to have remained housed, for the most part, in structures planned for single families.

The data in the Real Property Inventory in regard to the condition of structures are based on the judgment of the enumerators, who classed them as "good," "needing minor repairs," "needing structural repairs," or "unfit for use," according to their conception of local standards. Sixty per cent of all the residential structures in the 64 cities were found to need repairs of some sort, but in only one-fourth of the cases were the needed repairs of a structural nature. The average percentage of structures in good condition is 37.5 per cent, and

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of those unfit for human use, 2.3 per cent. The best conditions are reported in the Northeast, where the median percentage for structures in good condition is highest and that for structures unfit or needing major repairs is lowest. On the basis of the average number of dwelling units per structure, there are 60,000 dwelling units in the entire group of cities in structures not adequate for use.

More than three-fourths of all the structures enumerated have been built since 1900, in spite of the fact that a number of the cities included were founded early in the country's history. The proportion of old structures in each city, in general, declines as the distance from the eastern seaboard increases; the proportion of structures built since 1920 increases (to more than 60 per cent in some cases) in those areas, especially in the Southwest, where rapid population growth was taking place in the 1920-1930 decade.

The slump in building activities since 1929 is reflected in the number of structures built per year in the past five years and in the preceding ten years. The 64 cities taken as a group have been building at the rate of 26,000 structures a year from 1929 to 1934, a 60 per cent decline from the annual rate of 65,000 structures in the ten years from 1919 to 1929. The Census of 1930 reported about 2,075,000 families in these 64 cities (exclusive of the families in the environs making up the metropolitan areas) in 1930, and the gain in families from natural increase alone would absorb most of the new living quarters, with no adequate provision made for the gains in the demand for dwelling units due to inward migration from outside areas or for losses in dwelling space due to conversion to other uses, fire, or demolitions.

HOME FACILITIES

The cities in the various sections of the United States differ strikingly in the proportion of their homes equipped with the fundamental facilities making for convenience. Running water

TABLE I
SELECTED DATA ON 64 CITIES
WITH REGARD TO HOUSING AND HOME EQUIPMENT

Items	Median for 64 Cities	Extremes			
		Low City		High City	
		Per Cent	Place	Per Cent	Place
Per Cent of Structures which are Single Family Houses.....	84.9	54.0	Providence, R. I.	95.0	Springfield, Mo.
Per Cent of Dwelling Units in Single Family Houses	67.5	28.9	Portland, Me.	86.9	Springfield, Mo.
Per Cent of Structures Built of—					
Wood.....	84.7	1.5	Sante Fe, N. M.	96.8	Providence, R. I.
Brick.....	8.2	0.4	San Diego, Calif.	61.4	Salt Lake City, Utah
Concrete or Stucco.....	2.9	0.4	Portland, Me.	35.8	{Phoenix, Ariz. Minneapolis, Minn.
Per Cent of Structures—					
In Good Condition.....	37.1	20.2	Paducah, Ky.	55.4	Binghamton, N. Y.
Needing Minor Repairs.....	44.4	34.0	Charleston, S. C.	54.2	Jackson, Miss.
Needing Structural Repairs.....	16.5	6.8	Binghamton, N. Y.	31.4	Paducah, Ky.
Unfit for Use.....	1.9	0.4	Binghamton, N. Y.	8.0	Paducah, Ky.
Per Cent of Structures Built—					
Since 1920.....	35.6	6.7	Butte, Mont.	65.8	Oklahoma City, Okla.
Before 1885.....	5.8	—	Wichita Falls, Tex.	38.6	Charleston, S. C.
Per Cent of Occupied Dwelling Units with Resident Owner.....	43.2	20.0	Charleston, S. C.	53.3	Racine, Wis.
Per Cent of Occupied Units Having Present Tenants—					
Less than one year.....	31.3	18.9	Trenton, N. J.	51.5	Phoenix, Ariz.
More than ten years.....	23.6	11.4	Oklahoma City, Okla.	32.5	Williamsport, Pa.

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TABLE I—Continued

Items	Median for 64 Cities	Extremes			
		Low City		High City	
		Per Cent	Place	Per Cent	Place
Per Cent of Dwelling Units Vacant.....	7.0	1.8	Jackson, Miss.	15.9	Butte, Mont.
Per Cent of Vacant Dwelling Units Unoccupied for Less than 6 Months.....	58.6	26.4	Butte, Mont.	76.2	Oklahoma City, Okla.
More than 2 Years.....	13.0	4.3	Albuquerque, N. M.	40.4	Butte, Mont.
Per Cent of Dwelling Units with Space					
Adequate or Better.....	83.4	60.4	Charleston, S. C.	91.9	Portland, Ore.
Overcrowded.....	1.4	0.2	Lansing, Mich.	10.3	Charleston, S. C.
Per Cent of Dwelling Units with—					
Running Water.....	92.2	70.4	Paducah, Ky.	99.6	Burlington, Vt.
Central Heating.....	46.4	0.4	Shreveport, La.	86.9	Lansing, Mich.
Lighting by Gas or Electricity.....	93.9	50.0	Charleston, S. C.	98.8	Butte, Mont.
Cooking by Gas or Electricity.....	76.7	19.0	Knoxville, Tenn.	94.6	Cleveland, Ohio
Private Indoor Sanitary Facilities.....	81.1	51.3	Charleston, S. C.	98.3	Burlington, Vt.
Tub or Shower.....	74.2	43.8	Charleston, S. C.	91.4	San Diego, Calif.
Mechanical Refrigeration.....	16.0	6.4	Paducah, Ky.	27.6	Lincoln, Neb.
Average Number of Rooms in Dwelling Unit.....	5.0	3.6	Butte, Mont.	6.3	Trenton, N. J.
"Extra" Families per 100 Occupied Dwellings.....	7.1	2.5	Casper, Wyo.	13.5	Jacksonville, Fla.
Passenger Automobiles per 100 Occupied Dwellings	55.4	29.0	Charleston, S. C.	72.2	Lincoln, Neb.
Other Data:					{ Sacramento, Calif.
Population in City Limits in 1930.....	73,400	11,200	Sante Fe, N. M.	900,400	Cleveland, Ohio
Per Cent Native White.....	82.0	52.3	Charleston, S. C.	95.4	Springfield, Mo.

and bathroom facilities have come to be regarded as the minimum in household equipment with which any American family, unless it is in a remote area, can be expected to be content. Nevertheless, those facilities are far from universal.

The older cities of the Northeast (east of Ohio and north of the Ohio and Potomac rivers), as might be expected, have the highest percentage of homes reporting running water, bathtubs or shower baths, and private indoor toilets. By no means all homes in this area can boast of all those advantages, but only Wheeling and Wilmington stand out as cities where more than a negligible fraction of the families must do without running water. In Wilmington, eight per cent of the dwelling units are without it, and in Wheeling more than 26 per cent. Tubs or showers are, of course, much less prevalent in dwellings than running water. Among the northeastern cities, Binghamton is best supplied, with all but 9.2 per cent of the dwelling units having tubs or showers; and Wheeling least adequately supplied, with almost half of its dwellings without such facilities. Generally, more homes have private indoor toilet facilities than have bathtubs or showers, but even in this relatively well equipped area about 10 per cent of the dwelling units report no such conveniences.

Away from the northeastern area, the average percentage of dwelling quarters without proper facilities rises considerably. Instead of a median of 2.5 per cent of dwelling units without running water, as in the group of northeastern cities, the median among western cities is 5.8 per cent, in the Middle West 8.0 per cent, and in the South 13.7 per cent, while in one community, Paducah, Ky., the figure reaches 29.6 per cent. The medians of the percentages of homes without their own indoor toilet facilities are 8.7 per cent for northeastern cities, 17.1 per cent for western, 18.6 per cent for middle-western, and 29.8 per cent for those in the South. Tubs or showers are not installed in an average of 17.4 per cent of these northeastern cities' homes, in 18.2 per cent of those in western states,

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in 25.2 per cent of those in the middle-western group, and in 35.3 per cent of the southern cities' dwelling quarters.

The proportion of homes with central heating (that is, a furnace providing steam, hot water, or hot air heat) is affected both by economic conditions and by climate. Figures for cities of the South and Southwest range about a median of less than 10 per cent of homes with installed furnaces; among western cities the median is 40 per cent, but temperatures vary so widely for that group that the figure is not especially significant. The percentage of homes so equipped ranges from 7.0 per cent in San Diego to 65.0 per cent in Portland, Ore. More nearly uniform climatic conditions prevail in the Northeast and Middle West, however, and all houses require some provision for heating. Consequently, economic conditions are the more influential, and the contrast between the Middle West, where the average city has 25 per cent of its dwelling units heated otherwise than by furnace, and the Northeast, where 37 per cent must depend on stoves or less efficient means, is striking on that account. The most heavily industrial cities of the Northeast—Providence, Worcester, Waterbury, and Wheeling—all have less than half of their living quarters heated by furnaces.

In three-fourths of the cities, coal is still the dominant fuel used for heating, and in most of the others (mainly in the Southwest) natural gas heats the largest proportion of homes. Fuel oil has been adopted by some families in practically all of the communities, but in only seven cities are as many as 10 per cent of the dwelling units heated by this means. The seven—all remote from coal fields—are Portland, Me., Nashua, N. H., Burlington, Vt., Worcester, Mass., Lincoln, Nebr., Portland, Ore., and Seattle, Wash.

The prevalence of adequate lighting in the cities throughout the country is reflected in the small percentage of homes not lighted by gas or electricity. Medians for the Northeastern and the Western cities included in the Inventory are the same,

3.1 per cent of the dwelling units depending on other means than gas or electricity; the median in the Middle Western group is 4.2 per cent, while in the South it is 27.8 per cent. These figures serve to emphasize what data on other facilities have indicated: the contrast between housing conditions in southern cities, with their large proportion of negro population of low earning power, and in cities in the remainder of the country. On the basis of these 64 cities, the average percentage of southern urban dwellings without gas or electric lights is greater than the highest percentage occurring in any city outside that section.

Cooking by means of gas or electricity is, of course, not so common as lighting. Gas is the most usual fuel, and yet more than one-quarter of the dwelling units in these 64 cities are not equipped for the use of either gas or electricity for cooking. Southern cities again are conspicuous in that a high average of homes use some other fuel; Asheville and Knoxville are especially high, each with less than one-fourth of their dwelling units using gas or electricity. The average proportion of homes using gas or electricity for cooking is slightly higher for places supplied with natural gas than for those not so supplied, but the difference is too small (79.5 per cent as against 73.6 per cent) for the presence of that cheap and efficient fuel to be considered a factor in the popularity of gas for cooking purposes in many communities. The lower cost of coal or wood is probably more influential in limiting the use of gas in the majority of cases.

GENERAL HOUSING CONDITIONS

The Real Property Inventory reveals that of the more than 2,600,000 dwelling units available in the 64 cities at the time of the enumeration, about 1,000,000 were occupied by the owners, 200,000 were vacant, and the remaining 1,400,000 were rented. The number of rooms per dwelling unit and the

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number of persons per room indicate that in most of the 64 communities the major part of the population is adequately housed so far as space and opportunity for privacy are concerned.

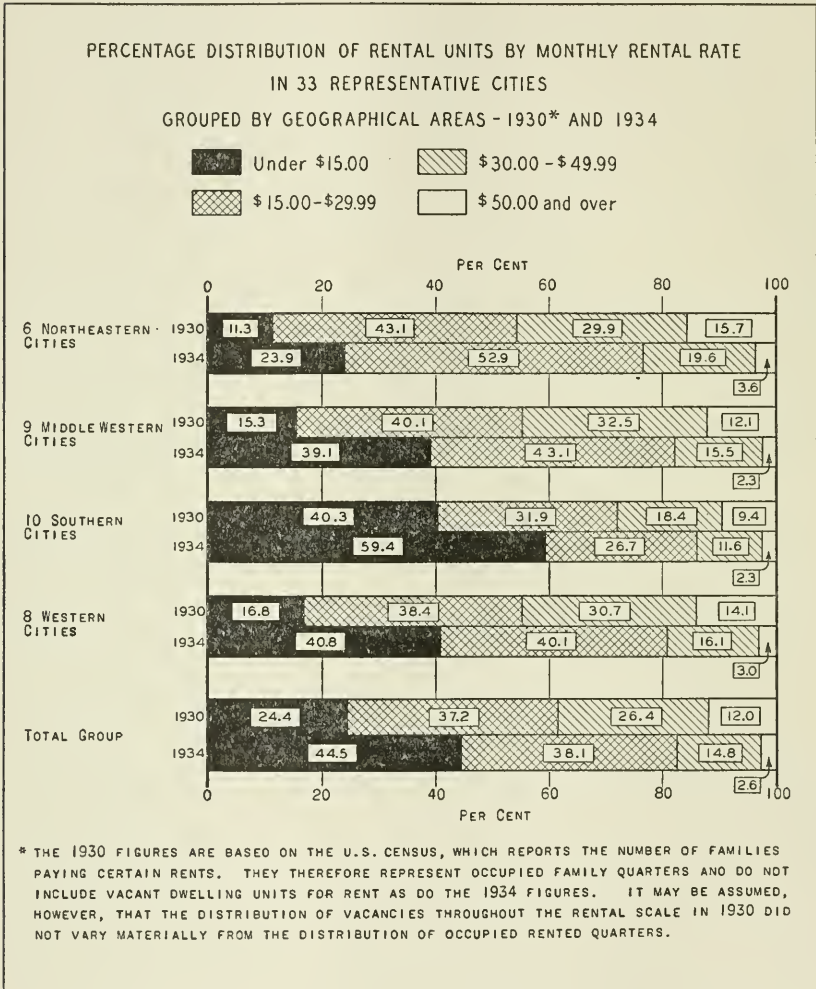
Among the occupied dwelling units, 83 per cent were reported to provide space adequate—or better than adequate—for the number of people living there (one person or less per room is considered to indicate “adequate” living space), 15 per cent were crowded (one to two persons per room), and two per cent were overcrowded. The enumerators’ interest was not primarily in population, and it is possible that the proportion of homes reported to be adequate may be somewhat higher than is actually the case, since it might be expected that some of those interviewed would report only the number of family members and omit mention of any roomers or servants also living there. To some extent the adequacy of dwelling quarters varies with the average number of rooms in the homes of these cities. The median of the average number of rooms per dwelling unit for the entire group is 5.0, while that of the cities in the Northeast is 5.9, of those in the Middle West 5.15, of southern cities, 4.6, and of western communities 4.5. Trenton has the highest proportion of large homes, with an average of 6.3 rooms, and Butte the lowest, with an average of 3.6 rooms.

About 30 per cent of all the dwelling units in the 64 cities have had new tenants within a year, nearly another 30 per cent have had the same occupants from one to five years, and over 40 per cent have had no change in occupants for more than five years. In view of the 43 per cent of homes reported owned by the occupants, with a high degree of residential stability, renting families must move much more frequently than is indicated by the above figures.

Rentals

That the income to landlords from rented dwelling units has dropped materially since 1930 is shown by the data for

the 33 cities where enumerations of this item made in 1930 and 1934 are on a similar area basis. The figures themselves are not exactly comparable, since the Census covers only occupied



homes renting at specified levels, whereas the Real Property Inventory includes, in addition, vacant dwelling units for rent. This variation in viewpoint explains in part the difference between the 200,600 rented homes in 1930 and the 247,300 rental

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units in 1934 (probably most of the 27,400 vacant dwelling units in 1934 are for rent); no doubt an increase in rental units has also occurred as a result of foreclosures or of an effort on the part of property owners to forestall foreclosure by leasing their homes and renting cheaper quarters for themselves. In spite of this difference in the total figures, however, it is probable that the distribution by rentals at each date is not much affected. The accompanying chart shows the differences in rent levels at the two dates and also brings out the variations in general rent conditions by geographical regions.

Besides these comparisons, the medians at the two dates present some interesting contrasts. In 1930 the median percentage of homes in these 33 cities renting for less than \$15 per month was 19.0 per cent; in 1934, 41.8 per cent. Similarly, the median percentage of units renting for less than \$30 was 64.3 per cent in 1930 but 82.6 per cent in 1934; while at the upper end of the scale the median of units renting for \$50 or more was 11.3 per cent in 1930 but only 4.6 per cent was in that group in 1934. Reports for 40 of the cities surveyed in 1934 show more than half of the rental units available for \$20 or less per month; in fact, in 17 cities half of the units might be had for \$15 or less, while in two communities more than 50 per cent might be rented for under \$10.

Home Ownership

The approximately 1,000,000 dwelling units with resident owners represent less than 43 per cent of the occupied dwelling quarters in this group of cities. More nearly uniform conditions prevail throughout the North and West in home ownership than in many other respects (approximately 45 per cent), but homes occupied by the owners in the South amount to only 34 per cent of the total occupied dwelling units. At the time of the 1930 Census, 42.8 per cent of all urban homes were owned; thus the status of home ownership as a whole in urban

areas does not appear to have been materially affected by the years of depression. In the cities where some comparison with 1930 conditions is possible, 43.8 per cent of the homes were owned at that date and 40.3 per cent had resident owners in 1934. This decline measures to some degree the loss of homes under emergency conditions, but cannot reflect the total shift in home ownership by individuals, which has no doubt been considerable. In every community there have been many families forced to discontinue mortgage payments, with consequent loss, and also many buyers of such properties at bargain prices. The decline of almost 14,800 in the number of homes occupied by their owners, while the total number of occupied dwelling units was declining by only 3,900, is a further indication of the tendency for some owners to rent their homes and move to cheaper rented quarters.

In reply to the question asked property owners as to the value of their homes, the answers were sufficient either in number or in apparent accuracy to justify tabulation in only 38 cities, and even so more than 10 per cent of the owned homes in these cities are tabulated with no value reported. Since the values reported are the owners' appraisals, the figures may be assumed to represent various points of view—what was paid for the property, what the owner would have to be offered to let it go, or what he thinks he could get for it under present market conditions. With these qualifications in mind, it is interesting to note that in the 38 cities (24 of them being "metropolitan areas") two-thirds of the owned homes for which values were reported were valued at less than \$5,000 and that \$8,000 would be the upper limit of value for all but about 10 per cent of the homes. The largest single group is that of homes with values of from \$3,000 to \$5,000, which make up 30 per cent of the total number reported.

The downward revision in realty values in the last few years is illustrated by the changes in the distribution of owned homes by valuations from 1930 to 1934 in the 14 cities of the "city

limits" group where comparison is possible. Only 28 per cent of the owned homes reported in that group in 1930 were valued at less than \$3,000; in 1934 more than half were so valued. The same group (those valued at from \$3,000 to \$5,000) was the largest at both dates. At the upper end of the scale, 15 per cent of the owned homes were considered by the owners to be worth more than \$10,000 in 1930, but in 1934 only 5 per cent were so appraised.

Vacancies

Vacancies in the living quarters of a city indicate the existing space available for population expansion. A certain amount of vacancy represents a normal condition, where there is just about as much extra room as will accommodate the growth of the community in the immediate future. Vacancies large in proportion to the total dwelling units may be a sign of (1) an overbuilt condition or a large number of antiquated structures, (2) simple preparedness for a rapidly increasing number of families, (3) congestion where a considerable number of families are sharing living quarters with others for reasons of economy or, perhaps, because of a building shortage only recently corrected, or (4) a recent outward movement of population. Commercial surveys made by telephone engineers approximately ten years ago in 14 of these cities showed vacancy ratios ranging about a mid-point of 4.1 per cent. In most cases buildings under construction were included as vacant dwelling quarters, so that it is probable that a normal vacancy ratio at that time was about 3.5 per cent. About twice as many vacancies in proportion to the number of dwelling units were found in these same cities in 1934. In both periods, of course, the vacancies include a number of living quarters which are in too poor a condition ever to be used again.

The vacancy ratio of 7.8 per cent for the entire 64 cities does not indicate an overbuilt condition in many communities. The 204,000 empty dwelling units are counterbalanced by 184,000

"extra" families* (those sharing living quarters with the usual occupants) and 44,000 structures considered, by local standards, to be practically unfit for human habitation, although some were occupied. If these totally inadequate homes were eliminated, the number of potential householders now living with others would exceed the available living quarters by more than 25 per cent. It is probable that some of the "extra" families are now permanently established with the usual occupants, and also that when other families are re-established, their homes will not necessarily be in the same communities; but even so, the stored-up demand for housing and all its facilities is plainly a large one.

Of the 200,000 dwelling units vacant at the time of the enumeration, only a relatively small proportion had been standing empty for a considerable length of time. Fifteen per cent had had no tenants for more than two years, and another 13 per cent had been vacant for at least a year, but for 56 per cent the period was less than six months. It is noteworthy that the current causes of vacancy—decline in the rate of family growth, "doubling up" of families, or the movement of industrial workers away from cities to small towns or rural areas—seem to have taken effect in the cities of the Northeast earlier than in the other sections of the country. Outside that area the median percentages of vacant dwelling units unoccupied for less than six months are all approximately 60 per cent, while in the Northeast it is about 50 per cent; correspondingly, the median percentage of unoccupied units in that area vacant more than two years is about 19 per cent, whereas elsewhere it is about 12 per cent.

* The enumeration of "extra" families is a new and useful piece of information. The U. S. Census counts as one family all related individuals living under the same roof and sharing the same table, and any indication of "doubling up" can be obtained only by indirection from the movement of the ratio of persons to families.

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OTHER FEATURES

The Real Property Inventory covers various other points, some of which are particularly interesting from the standpoint of market opportunities in these communities. They show that there are more than half as many passenger automobiles in these 64 cities as there are occupied dwelling quarters and that 55 per cent of all structures have garages, with an average capacity of 1.6 cars. In the West and Middle West, the number of passenger cars per 100 occupied dwellings is especially high, 62.8 being the median among western cities and 59.5 for middle western communities. In the cities of the South and Northeast, however, the number of cars is less than half the number of occupied dwelling units (47.5 and 46.8 are the respective medians). For every 100 occupied dwelling units in the 33 places with a comparable area in 1934 and 1930, there are 54 passenger automobiles, as compared with 48 residence telephones on January 1, 1934 and 37 families with radios in 1930.

In view of the spread between the low and the high of the sectional medians in the ownership of automobiles, it is interesting to note that about the same degree of progress has been made in providing mechanical refrigeration in cities in all parts of the country. The median among western cities is the highest, at 17.5 per cent of all dwelling units, and lowest in the South, at 14.1 per cent.

The number of homes owned clear of mortgages is a factor in judging the quality of markets. Nearly half of the owned homes in the 14 smaller cities and more than a third in the 24 metropolitan areas for which the information is available have no mortgages. These are minimum percentages, since for about 14 per cent of the owned homes the terms of tenure are not reported.

CONCLUSION

This discussion of housing and its facilities has served to bring out the facts that urban housing conditions vary widely in different parts of the country, that in every city—at least so far as these 64 communities are typical—there are numerous families (in some places a considerable portion of the population) inadequately provided with ordinary conveniences, and that there is a large unsatisfied demand for housing, represented by the excess of families living with other families over the number of vacant dwelling units suitable for use.

There should perhaps be added a note of caution as to the use of figures for specific communities. In view of the conditions under which the Real Property Inventory was taken in most cities, with a hastily trained group of workers making the survey in a limited time, it would be unreasonable to expect complete reliability. Some internal evidence was found that the enumeration was not accurate in every detail, and it is probable that when the final reports are issued they will contain some changes from these preliminary tabulations.

DOROTHY BOLLES

The following cities (metropolitan areas starred) were included in the Inventory:

<i>Northeast</i>	<i>Middle West</i>	<i>South</i>	<i>West</i>
Portland, Me.	*Cleveland, Ohio	*Richmond, Va.	Butte, Mont.
Nashua, N. H.	Zanesville, Ohio	Asheville, N. C.	Boise, Idaho
Burlington, Vt.	*Indianapolis, Ind.	Greensboro, N. C.	Casper, Wyo.
*Worcester, Mass.	Decatur, Ill.	Charleston, S. C.	Pueblo, Colo.
*Providence, R. I.	*Peoria, Ill.	Columbia, S. C.	Albuquerque, N. M.
*Waterbury, Conn.	Lansing, Mich.	*Atlanta, Ga.	Sante Fe, N. M.
*Binghamton, N. Y.	*Kenosha, Wis.	*Jacksonville, Fla.	Phoenix, Ariz.
*Syracuse, N. Y.	*Racine, Wis.	Paducah, Ky.	*Salt Lake City, Utah
*Trenton, N. J.	*Minneapolis, Minn.	*Knoxville, Tenn.	Reno, Nev.
*Erie, Pa.	*St. Paul, Minn.	*Birmingham, Ala.	*Seattle, Wash.
Williamsport, Pa.	*Des Moines, Iowa	Jackson, Miss.	*Portland, Ore.
*Wilmington, Del.	St. Joseph, Mo.	*Little Rock, Ark.	*Sacramento, Calif.
Frederick, Md.	Springfield, Mo.	Baton Rouge, La.	*San Diego, Calif.
Hagerstown, Md.	Fargo, N. D.	Shreveport, La.	
*Wheeling, W. Va.	Sioux Falls, S. D.	*Oklahoma City, Okla.	
	Lincoln, Neb.	Austin, Tex.	
	Topeka, Kan.	*Dallas, Tex.	
	*Wichita, Kan.	Wichita Falls, Tex.	

The Changing Years as Seen from the Switchboard

Editor's Note:

The interviews appearing under the above title in current employee magazines of the Bell System are reprinted here, beginning with the first two, as affording an interesting supplement to "Opportunities for Women in the Bell System" which was published in the BELL TELEPHONE QUARTERLY for January, 1932.

I. ON THE IMPORTANCE OF LOOKING BACKWARD

NUMBER PLEASE? On something like sixty per cent of the 17,000,000 Bell-owned and Bell-connecting telephones which serve America (the sixty per cent connected with manually operated central offices), every local and long distance call is inaugurated by these two words—*spoken by a woman*.

More eloquently than bare statistics, these two words bear testimony to the fact that women play an essential part in the provision of telephone service. If that part were played one whit less intelligently, efficiently and loyally than it is by the 150,000 Bell System women who are engaged in one form or another of telephone work, America's nation-wide telephone service could not be what it is today.

This much is a fact universally accepted by all who know even a little of what goes on behind the scenes of this communication system which links a nation's millions of people and makes them neighbors. Perhaps it is a fact that has become altogether too easily accepted: so easily accepted that it is taken as a matter of course.

How has it come about that women have won their well-earned place in this vitally important national service? Did woman drop into this leading rôle in the telephone drama by

mere chance? Has anybody tried to find out how this composite figure—The Woman of the Telephone Service—became what she is?

Make no mistake about it, those who are responsible for the management of the Bell System have made it their business to trace the long evolution that leads from the first women telephone employees, working at primitive switchboards, to the Bell System woman of today. They could not have done otherwise. They could not do their job today, or prepare for that of tomorrow, without looking long and carefully at what happened yesterday.

That is the way the Bell System has to do things, for telephone service is an unending evolution. One transmitter or receiver gives way to another; a switchboard is developed to meet new needs and displaces another which thereby becomes obsolete; cables are discarded to make way for others of larger capacity or greater efficiency. No Bell System executive or engineer would pass upon the merits of a thing as seemingly simple as a switchboard jack without studying the accumulated experience of those who have designed or made switchboard jacks for the past fifty years. In the provision of telephone service, the only way to look forward is to look also backward.

But telephone service is not merely a matter of mechanisms. It is primarily a matter of manpower. For the purposes of the series of interviews to which this forms the introduction, perhaps one may be permitted to coin a word and say that telephone service is to a very considerable extent a matter of *woman-power*. And properly to utilize the full force of the power that lies in the loyalty, devotion to duty and efficiency of its women, the Bell System has to look not merely at the present, nor toward the future, but also toward the past.

That is why Miss Laura M. Smith, assistant to Vice President E. F. Carter, of the Personnel Department of the American Telephone and Telegraph Company, readily assented when

it was proposed that she submit to being interviewed regarding the contents of certain red-covered, loose-leaf binders which she never allows to be taken far beyond her reach. These books Miss Smith considers very precious, just as any other good workman highly prizes the tools with which his job is done. They contain a mass of data, carefully arranged and digested, which the Personnel Department has obtained from more than 200 men and women who were engaged in the telephone service in its early days: from about two years after the telephone was invented to the first decade of the present century. This information deals, directly or indirectly, with the part which women played in the telephone service during this formative period of telephone history.

"You see," said Miss Smith, opening one of the books, "we wanted a true picture of what the life of the woman telephone employee in those early days really was; and in the very early days, that meant the telephone operator, for there were relatively few other telephone jobs held by women during the first decade or two of telephone history. We wanted to see this picture through the eyes of those who had not merely looked at what took place during those days, but who were themselves actively engaged in telephone work. We wanted eye-witness testimony.

"We had certain concrete things we wanted to find out—how women came to be employed as operators, instead of the boys who first 'manned' the telephone switchboards; what prompted these young women to take up this kind of work; something about the mechanism of the equipment in central offices and about the method of operating it; what was done about training the operators; what kind of working conditions there were during these early years; what the relations of these young women were with the public they served; enough about working hours, wages and a lot of other things to obtain a really accurate idea, to use a modern expression, of what it was all about.

"Whenever possible, we of the Personnel Department here at headquarters got in touch with the individuals themselves and arranged for personal interviews. When this was impossible, as it was in many cases—for these pioneer telephone women were scattered all over the country—we called upon the Personnel Departments of the Associated Companies, and through their co-operation obtained the personal reminiscences of many more operators. When it was impossible to interview these women in person, we sent them a questionnaire or memorandum of the information we hoped they would be able to give us, and they wrote us, giving this information. After the whole mass of material had been collected and analyzed—and in this analysis I had the able assistance of Miss Ruth Currier, of our Personnel Department—it afforded about as complete a composite picture of the pioneer telephone woman as it would be possible, I think, to obtain.

"But that was not enough. We were fascinated by the story that could be told us by the men who, as harum-scarum lads, had been the first telephone operators. We knew we had to get that story, in order that we might have a clear picture of the background against which these first Bell System women were seen as they made their entrance, more than half a century ago, upon the telephone stage. Mr. C. R. Thompson, of the Department of Operation and Engineering of this company, helped us to 'round up' thirty-five or more of these original boy operators. He explained to them the purpose of collecting this material and kept in touch with them until they had answered their questionnaires.

"The information obtained from these former boy operators is—well, if you insist on interviewing me (and I think that, for once, I am going to enjoy being interviewed) you'd better begin with those boys."

Miss Smith was assured that the "boys" in whom she had shown so solicitous an interest would be given first attention. Then she hastened to explain that, even after collecting as

much material as could be obtained from the operators of both sexes, she and her colleagues of the Personnel Department had not been satisfied that the picture they were trying to reconstruct was complete. There were still living a few of the men who had hired these boys and young women, who had watched them at their work, had been responsible for such training as they were given and who, in a vast majority of cases, had known them well enough to call them by their first names. These men also had some testimony to offer that would be valuable, and steps were taken to obtain it.

There still are, incidentally, an extraordinary number of women in the Bell System who may be classed as trail-blazers of the telephone service. At the beginning of 1934 there were 1173 women Bell System employees with periods of service of thirty years or more. Of these, forty-eight had forty years or more of service, and five had been in telephone work forty-five years or more. Retirements have doubtless reduced these totals considerably, but the fact remains that in the telephone business, long periods of service, for men and women alike, are by no means rare.

It is hoped that the present series of interviews with Miss Smith will prove interesting to women who have been long in the service, for all that these interviews are to contain will be based on the eye-witness evidence of pioneers like themselves. It is hoped that the younger women, too, will find in the series which begins with this issue something of interest and inspiration. And finally, it is hoped that the older men of the telephone service may find here not a little that recalls the stirring days through which they have lived, and that their younger brothers may feel themselves repaid for reading what may at first seem to be merely another telephone history.

The years have brought many changes, but they have been changes in which all telephone people, men and women, veterans and novitiates, have had their part, working shoulder

to shoulder. There will be many changes in the years that are to come, and they will be brought about in the same way.

II. THOSE BOY OPERATORS

"Well, what about those boy telephone operators of yours? You know, you promised us a story on what you learned from them about the early telephone days. Have you time to talk about it now?"

We admit that there was a challenge in our voice as we hurled these sentences at Miss Smith. We intended that there should be a challenge in it. We had never thought much of those boy operators. Perhaps our opinion of them had been prejudiced by the writings of the late John J. Carty, who in his early youth had been one of these same boy switch-manipulators in a telephone office in Boston.

"They were very poor operators," he once declared. "They were not old enough to be talked to like men and they were not young enough to be spanked like children. I shall never forget the noise that was made by those young fellows." Some years after this not too commendatory appraisal of the boy operator as he had known him, General Carty, then one of the commanding figures in the telephone world, remarked: "My colleagues of that time were what I think the ethnologists would rank but a little lower than the wild Indian!"

No, we had not thought much of boy operators and we intended that Miss Smith should understand our position, right at the start. Perhaps she did.

"My boy operators," she smiled, "I am glad you have put it that way. You know, I can't help feeling a sort of proprietary interest in those youngsters, as they were when they were at the switchboard, in spite of all the criticism that has been heaped upon them. If you read what they have written here—"

Miss Smith interrupted herself to push across the desk one of the red-covered binders which had been the real cause of

all this interview business. We knew from the expression in her eyes that she was getting ready to quote chapter and verse in defense of the boy operators. And she did. With an eager forefinger she pointed to interesting little incidents in the telephone life of a boy who became a telephone "man" in Pittston, Pa., in 1879, at the mature age of thirteen; to others who began at the switchboard a few years later, at approximately the same age, and who, step by step, advanced to positions of high responsibility in the telephone service. One does not have to read far in such a record to come to the conclusion that these boy operators were, after all, a very human lot of individuals who, by and large, made the best of a hard job.

Theirs was a hard job, make no mistake about that. Not because they had to leap from switch to switch with the agility of the monkeys they were; to sweep out the office and keep coal on the fire; to run errands and now and then collect bills or go out to untangle a pair of slack wires which had become wrapped around each other in a high wind—not that. Young muscles are resilient, and so are young hearts and minds. Their job was hard because, when one gets down to essentials, it was a job for which they were not fitted by temperament or training.

It was the most natural thing in the world to use boy operators in the first telephone exchanges. Boys and young men had served as telegraph operators ever since Morse had ticked off his historic "What hath God wrought." So why not put the boys at the telephone switchboards? At the switchboards the boys were put—with just about the same degree of success as attended the attempt to borrow cable and iron wire and even the switchboards themselves from the telegraph business and adapt them to the newly-born telephone art. Like these mechanisms which pioneer telephone engineers tried to fit into the telephone service in its early days, the boy operators served well enough for a while: until something better was found.

What was found, of course, was the woman telephone operator. But that is another story.

Miss Smith swiftly turns the pages of the red binder, pointing to notes on interviews with these men who in their youth had been the first guardians of the Bell System's switchboards, or to their answers to a questionnaire which the Personnel Department had sent them. As she comes to some particularly interesting or significant point, she stops to comment on it, almost as if thinking out loud.

"You know," she says, earnestly, "since collecting this material and studying it, one thought has recurred to my mind again and again. We call these people—the men and women and the boys of the first years of telephone history—'pioneers.' I wonder whether we stop to think how true a description this is of what they were? When we read what they—the boy operators and the women operators alike—have written here, we see very clearly that they were actually living and working amid pioneer conditions. They were blazing a trail and pushing forward a frontier, just as did the men and women who settled the West.

"They worked with communication equipment as relatively crude as were the prairie schooners that creaked their way across the prairies and over the mountains to the Pacific. They worked long hours and had to face a thousand obstacles. They had to keep constantly on guard against discouragement. But they kept on.

"I suppose we of this day can have no conception of how crude, as compared to modern telephone apparatus, the switchboards of that day were. See what this former boy operator says about the equipment at which he began work:

Our switchboard was a wonder. It looked like a cross between an oldtime telegraph switchboard and a bread toaster. The "indicators" were a number of ordinary bell boxes of different sizes and were fastened to the wall directly over a Blake transmitter. The tone of each and every bell was exactly alike,

THE CHANGING YEARS—FROM THE SWITCHBOARD

and I was in receipt of many complaints for slow answers because of the difficulty I had in finding which bell rang whenever I was called.

“Outside plant,” Miss Smith continues, “was no better than central office equipment, and sometimes the boy operators had to do double duty, taking care of minor troubles with the lines. This same boy describes one method, apparently original with himself, of dealing with outside plant trouble:

Because of the small amount available for the purchase of poles, it was necessary to be saving of them, with the result that our construction gang in planting poles made the distance between them as great as the strand of wire would permit. It was only natural, therefore, that two parallel lines swinging between poles 300 feet apart would become “crossed” by every strong gust of wind. When this happened I followed the course of the line out of town with a wagon spoke in my hand, and on reaching the point of trouble, a well-aimed throw of that wagon spoke knocked out the “cross.” Then, walking back to town, I would resume business.

“You see, don’t you,” Miss Smith asks, “what I mean when I say that these boys were working under pioneer conditions—in the ‘prairie schooner’ stage of telephone development?”

There are scores of instances which prove that the boy operators of these early days of the telephone developed, of necessity, an initiative and a resourcefulness in dealing with unexpected difficulties: the pioneer’s characteristic knack of adapting himself to circumstances. When switchboards refused to function properly, these lads transformed themselves into telephone engineers and created some sort of make-shift with which to deal with the difficulty.

In the moments of leisure between calls—for traffic was often light in those days—these youngsters often occupied themselves with amusements that are also suggestive of pioneer days in the far West. There was something of the cowboy in them all, and the pranks they played upon each other and,

it must be admitted, upon subscribers, had an abandon about them that often approached boisterousness.

Some things, however, they took seriously. When they had to report to a subscriber that a line he wanted was busy, they expected themselves to be believed. If their word was doubted, as it not infrequently was, there was an exchange of amenities over the wire which often involved a short and ugly noun and sometimes an almost as short and even uglier adjective. There were reciprocal threats of punched heads and other bodily injuries and, now and then, an overt act of physical combat. They were a virile lot, those boy operators.

But, in spite of their pranks and their two-fisted assertion of what they conceived to be their rights, their subscribers liked them. Once more after the fashion of pioneers, there was a free and easy relationship between these youngsters and young men and the public they served. Subscribers were constantly calling upon them for services which today would be far outside the limits of a telephone operator's duties, and these services they cheerfully performed.

Doctors who left their offices expected the operators to keep track of the sources of incoming calls during their absence, so that they might call back when they returned; heavy sleepers gave orders to be called at a specified time each morning; business and professional men wanted errands run. Here, for example, is a paragraph from the reminiscences of one of the New Jersey boy operators:

It was the custom of some of our big men to telephone from New York to the Bayonne operator and say "Tell Barney to meet me on the 11:30." The business then was for the operator to shout out through the window across to the station cab man: "Hey, Barney, meet Mr. A. on the 11:30." Subscribers making such requests invariably added, "I'll fix you up for this some time." Fixing, however, never took place.

Miss Smith closed the red-covered binder and handed it to the writer for further study.

"Be sure to bring it back," she said. "You'll find a lot of interesting things in it—too many to put in one interview, I'm sure. But I venture to say you will find nothing more interesting or significant than what these men who were boy operators have said about the job they did, as compared with the way that same job was done, after they had left the switchboard, by the women who took their places. You'll find a lot of things like this—"

She reached for the binder again, opened it and pointed to these words:

As much as boys thought of their ability as operators, it is my opinion that even though boys had had the same systematic training as received by female operators, the boys would rate a poor second best. The boys perhaps were able to stand more wear and tear in the distant past hurly burly traffic conditions. They were, however, in the habit of following their own operating practice and assuming their own responsibilities. . . . I believe it would be difficult for boys ever to fall in line with the present day efficient operating practices which seem to come so easy to the female operators.

This analysis, presumably unprejudiced, since it is from the pen of one who himself had been a boy operator, provides the explanation of the disappearance of these lads and young men from the telephone central office. One by one they went their way, except in such rare instances of group displacement as occurred in Scranton, Pa., when half a dozen boys quit the switchboard to celebrate St. Patrick's Day and found, to their chagrin, that their jobs had been taken by girls when the celebration was over. By the late 'eighties, girls were operating practically all Bell System switchboards during the daytime. There are still a few male night operators in small, outlying offices of some of the Bell System companies. The use of boys and young men as night operators was fairly common, even in the larger cities, until as late as 1903 or 1904, for it was not until the present century was well under way that it was uni-

versally considered quite safe or proper for a girl to take a job that involved being away from home after dark, even if she could do that job better than a man.

That not a few of these lads possessed large amounts of potential ability is evident from the fact that many of them went into other branches of telephone work and that, of these, some rose to high positions of responsibility as leaders in the telephone service. But whether they went on to these higher rungs of the ladder or not, they served their purpose while they were at their switchboards. They were pioneers, with the virtues and sometimes the small vices that go with the pushing forward of frontiers. Harum-scarum little curmudgeons though some of them were, they wrote an important chapter in the history of communication. They helped to build a nation-wide telephone service.

R. T. BARRETT

(To be continued)

International Radio Technical Committee Meeting of Lisbon, 1934

AN international radio conference of some general interest was held last fall at Lisbon, Portugal, by the International Radio Consulting Committee, commonly termed the CCIR.

There is given in what follows, first, an indication of the problem which occasions meetings of this kind and of how the world coördination of radio is being effected, and, second, an outline of what happened at the Lisbon Conference itself.

Radio may be likened to a huge, carrier current, multiplex system with the common "line" medium shared throughout the world by radio services of various types and nationalities. The multiplicity of channels which go to make up this multiplex system requires coördination if general interference is to be avoided. The situation is helped by the fact that not all the radio channels are intercontinental in their effect. A degree of uniformity in the uses to which the waves are put follows from the fact that the waves in the different frequency bands have much the same physical characteristics throughout the world and tend naturally to be put to similar uses. A certain fitting together of the channels is accomplished on a more or less trial and error basis by the various operating agencies of the world as the channels come into use. But obviously a more ordered arrangement and procedure is desirable, requiring definite world understanding.

WORLD REGULATION

The general coördination of radio channels has been accomplished by a world agreement which covers the general blocking out of the frequency spectrum to the different services and

certain general principles concerning the obligation which the nations have of avoiding interference. Such agreement has been reached through general international conferences, such as those of Washington, 1927, and Madrid, 1932, and takes the form of a convention or treaty. The convention now in force in the United States is that of the Madrid Conference of 1932, which constitutes the general frame within which the radio channels of the world are allocated. Actually, the Madrid Convention covers in a general way all forms of electric communications, but the United States Government's interest applies more particularly to radio because of the subject of frequency allocation and interference.

The making of a fairly full use of the radio medium without interference is dependent upon much more than the *general* regulation of frequency allocation. It is dependent, in the first place, of course, upon the more fundamental technical advance of the art which determines the extent to which the frequencies can be held constant and the channels can be segregated by a sharp frequency cutoff in the transmitting and receiving apparatus. It is dependent also upon such factors as the propagation characteristics of the waves, the geographical separation between stations, the relative power levels between channels, etc. Our knowledge concerning these factors comes, of course, primarily from the laboratories and operating plants within the different nations. This knowledge is rapidly spread throughout the world through the technical press. It is, however, desirable that the state of the art be reviewed from time to time and a consensus drawn as to what constitutes reasonably good engineering practice in respect to these technical matters. It is this which is done in international advisory conferences of the kind which was held by the CCIR at Lisbon. While the findings of such a conference are purely advisory, they have the weight of a world consensus.

In addition to the radio advisory committee, there are in existence two other advisory committees, one a committee on

international wire telephony (CCIF) and the other, a committee on international wire telegraphy (CCIT). The radio committee contrasts with the wire committees by being more formal and diplomatic in character. This is because its work is concerned so largely with the technical coördination of frequencies in the common radio medium and affects the military as well as the civil establishments of the nations. The international problems involved, evidently, are largely matters of governmental interest. The telephone advisory committee, on the other hand, is largely a matter of interchange of information and of determining reasonable standards for technical practices as among the telephone operating agencies. This is of particular importance on the continent of Europe in facilitating the interconnection of circuits of the different countries and the building up of an adequate toll system throughout that continent. The recent work of this telephone committee was outlined in the October, 1934, issue of the *BELL TELEPHONE QUARTERLY*. The telegraph advisory committee is of much the same character as the telephone committee.

RADIO TECHNICAL ADVISORY CONFERENCES

The Lisbon Conference constituted the third meeting of the CCIR since its formation in 1927. The two preceding meetings were concerned largely with putting order in the high-frequency (short-wave) bands. The first of these, held at The Hague, had set up as a general guide that the different nations of the world, in making wave-length assignments in the high-frequency range, should do so, so far as possible, on frequencies which are multiples of 5 kilocycles, this as a simple way of insuring some spacing of the channels. The second meeting, held at Copenhagen, rather specialized on radio transmitters and set up some limits to which the frequencies of transmitters should be held. The recent Lisbon Conference may be said to have made a beginning in considering radio as a *system*, for it studied questions of the suppression of undesired components at the

transmitting station, of propagation through the transmitting medium, and of characteristics of receiving sets.

To the Lisbon Conference the United States Government sent five delegates: one each from the Departments of State, Commerce, Navy, Army, and from the Federal Communications Commission. The delegation was headed by Dr. J. H. Dellinger, Chief of the Radio Section of the Bureau of Standards. Several of the United States operating agencies sent representatives, including RCA, Mackay Radio and National Association of Broadcasters. The Bell System was represented by Lloyd Espenschied and R. A. Heising, of the Bell Telephone Laboratories. The questions which were to come before the conference were studied in some detail beforehand in Washington in joint government-company committees.

OUTCOME

The general findings of the Lisbon Conference may be summarized as follows:

In the first place, it should be mentioned that European broadcasting seemed to be uppermost in the minds of the majority of the delegates and most of the technical questions were studied with this subject as a background.

A rather general interest was displayed also in the subject of radiotelephone service to small vessels, particularly fishing vessels in the North Sea. To care for a serious interference situation which had grown up in that area, the European nations most directly concerned drew up, outside the CCIR, a regional agreement constituting a channeling system for that service. The CCIR formulated a more general recommendation upon the subject of small-boat telephony, touching upon such factors as the need for high-frequency stability and for high receiver selectivity.

After much study, there was drawn up a set of propagation curves of signal field strength versus distance, for the range of frequencies involved in broadcasting (150 to 1500 kilocycles),

including European long-wave broadcasting. These curves have taken advantage of earlier work done in Europe and America and are perhaps the most authoritative of their kind in existence. Their principal usefulness is in estimating interference effects between broadcasting stations, particularly as between stations sharing the same frequency.

The way in which the quality of program transmission increases with the width of the frequency band transmitted was set forth in its bearing upon the frequency spacing which it is necessary to maintain between radiobroadcast stations.

The extent to which it is practicable to suppress the harmonics of radio transmitters was gone into and some limits were adopted which should be generally useful. There were not, however, sufficient data available to enable the subject to be covered very completely, and it is to receive further study at a future meeting.

The subject of receiving set selectivity was studied, having in mind its relation to the frequency spacing of radio channels. A mass of selectivity curves which had been presented showed that wide variations exist in receiving set selectivity and also that there was need for the further development and unification of measuring methods. The subject was put up for continued study on this basis.

The strength of the field which it is necessary to receive for the different services, in relation to noise as a fundamental limiting factor, was a subject of active interest. A certain amount of data had been collected on the field strengths now actually being used in the various services. The subject of noise and its method of measurement and evaluation were gone into. The whole subject of field strength and noise level was put up for further study.

Considerable interest was shown in the possibility of using for broadcasting single sideband with carrier transmission (i.e., one sideband eliminated). Some field tests of this method of transmission had been made in Holland and in England just

prior to the Lisbon Conference, and the whole subject was under active discussion in Europe. The conference did not find it possible to come to any final opinion but merely recommended that the experimental development of the subject be continued.

The question of the interference with radio reception, particularly with broadcast reception, which is experienced from man-made electrical sources, was discussed rather fully. This type of interference is local and not of international effect, and might be expected to be handled on a national basis. The European administrations, however, desire to handle the subject internationally as a means for obtaining uniformity in the noise suppression devices and practices to be applied. They anticipate legislation in the various countries of Europe and desire that the requirements placed upon manufacturers for electrical equipment, for example, be uniform throughout Europe. The subject is to be studied further in relation to the work being done by the International Electrotechnical Commission.

DIFFICULTIES

Naturally, the world does not get together in conferences of this kind without some difficulty, and a glance at this side of the picture will help to give a balanced perspective of the whole situation. In the first place, there are the difficulties of procedure, the problem of handling complicated technical questions in a large and rather formal gathering of delegates (there were some 160 at Lisbon), having quite different viewpoints and different native tongues. To an American the language difficulty is particularly troublesome. At Lisbon, English as well as French was used on the conference floor, with verbal interpretation given from one to the other, but all of the conference papers were in French. These were translated into English as rapidly as possible by the United States Government delegation, but frequently action was taken upon texts before the English rendition was available.

Perhaps the greatest difficulty from the standpoint of the United States resides in the fact that the European conditions differ so substantially from those in North America. The close proximity of the nations in Europe renders unusually difficult the sharing of the radio medium and tends to project into the international category problems which on the American side would be handled nationally or, at least, in a less formal regional manner. Examples of such problems are those of broadcasting, small-boat telephony, and interference with broadcast reception from man-made sources. The representation at the conferences being that of nations, rather than one of world regions or of communication development, gives to these conferences a great preponderance of European delegates and tends naturally to render them in large part European regional meetings. The difficulty presented to the United States' participation is not unlike that of the League of Nations. Nevertheless, the United States has taken an active and constructive part in these meetings, real progress has been made, and radio is perhaps an outstanding example of the attainment of a large measure of world agreement.

THE HOST COUNTRY

Portugal, land of the early navigators, provided a haven for the Lisbon Conference which the attending delegates will long remember as well suited to the practical purposes and delightful in its setting. The meeting place was at Estoril, a resort on the Coast of the Sun, some fifteen miles west of Lisbon proper. Several extended trips into the interior of the country, arranged by the reception committee of the Portuguese administration, gave the delegates a glimpse of a land of unusual interest in respect to its background, its beauty and present evidence of prosperity. It is truly a land of grapes, affording a spectrum of wines as interesting as the radio frequency spectrum which was under study!

The picture of this conference would not be complete without reference also to one of the mainstays of it, namely, the Berne Bureau. This is the centralizing body which carries out the secretarial and interpreting side of the meeting. Its work was excellent. Most unfortunately the head of the Bureau, Dr. Räber, passed away within a few weeks of his return to Switzerland.

One little highlight which might be added was that the Russian Soviet delegation was detained at the border and was not admitted to the conference by Portugal.

When the conference adjourned, the members found themselves, in effect, upon an island because the political disturbances in the adjacent country of Spain prevented return over the usual overland route. As a result, the delegates left Portugal by sea, a mode of travel not inappropriate to the traditions of the host country, nor to the early beginnings of radio itself.

LLOYD ESPENSCHIED

Notes on Recent Occurrences

TELEPHONE SERVICE EXTENDED TO JAPAN

TELEPHONE service with Japan was formally opened on Friday, December 7, 1934, thereby reducing to three the important telephone systems of the world with which the United States does not now have voice contacts. Only Russia, China, and New Zealand remain out of reach.

Interesting ceremonies inaugurated the service. In Washington, D. C., it was about seven o'clock in the evening of December 7, while in Tokyo it was nine A.M. of the following day, when Secretary of State Cordell Hull, Chairman Eugene O. Sykes of the Federal Communications Commission, and other government officials, and Vice President Arthur W. Page of the American Telephone and Telegraph Company, exchanged greetings with Foreign Minister Koki Hirota, Mr. Seichi Shindo, Director General of the Japanese Telecommunications Bureau, and other government and telephone officials in Japan.

In opening the ceremonies Mr. Page spoke as follows to Mr. Shindo:

"Good evening, Mr. Shindo. Mr. Shindo, this is Arthur Page of the American Telephone and Telegraph Company. We are in the office of the Honorable Cordell Hull, Secretary of State, who is present, as are also His Excellency Ambassador Saito and Judge Sykes, Chairman of the Federal Communications Commission. I am glad to have the opportunity at this opening of service of extending greetings from the Bell System to the Telecommunications Bureau of the Government of Japan and to assure you that we look forward to a long and happy association in which, we trust, we can together usefully serve the people of the two nations."

To this Mr. Shindo replied:

"We are assembled at the Tokyo Central telephone office. I have the honor to announce the presence of His Excellency Minister Tokonami, and their Excellencies Minister Hirota and Ambassador Grew. There are also present high officials of the Ministries of Communications, Foreign Affairs, prominent business men, and representatives of the news agencies. Mr. Page, this is Mr. Shindo, Director General of Telecommunications of the Ministry of Communications. Thank you for your kind greetings, which I heartily reciprocate. Please be assured that we are also looking forward to a long and happy association in which we trust we can together mutually serve the peoples of the two nations."

Mr. Takejiro Tokonami, Japanese Minister of Communications, then spoke with Judge Eugene O. Sykes, saying:

"Please accept my hearty congratulations on the opening of the radiotelephone service between Japan and the United States.

"The friendly relations between the two countries, as you are aware, date far back from the middle of the 19th century, when your Commodore Perry first came over to Japan on a special mission with the result that Japan, after closing herself to foreign intercourse, opened her door. Since then, the intercourse between the two countries has made rapid progress. Harmonization of civilization of the two resulted in mutual understanding and friendly relations, and at last have become the two great neighboring countries bordering the Pacific Ocean. Just at this moment it is very significant that a radiotelephone link has been established between Japan and the United States. This new service, I believe, will make cultural and economic ties of the two countries closer and closer and develop our traditional friendship to a great extent.

"I earnestly hope that this radiotelephone service will widely and freely be used, its functions be displayed to the

fullest degree and thus contribute to promote the welfare of and friendship between the two peoples."

Judge Sykes' response was as follows:

"It is indeed a pleasure to talk with you upon this momentous occasion of the opening of the direct radiotelephone communications between your great capital and ours. This is but another marvelous achievement whereby our nations are brought closer together and should further promote the cordial relationships existing between these countries.

"I must refer, with a great deal of pleasure, to the sincere co-operation which has always existed between your delegations and ours to International Radiotelegraph Conferences. We very much appreciate this cordial relationship and feel sure that it will continue in the future.

"May I personally wish you the best of luck and congratulate you upon your administration of communications in your great and beautiful country."

The next conversation was between Secretary of State Cordell Hull and Mr. Koki Hirota, Japanese Minister for Foreign Affairs. Mr Hull said:

"Mr. Hirota, this is Mr. Hull speaking. I am very glad to have this opportunity of greeting you directly and by voice, and it is a source of gratification to me to participate today with you in the inauguration of direct radiotelephonic communication between the United States of America and Japan.

"Eighty-one years have passed since the first official communication took place between our two countries. In 1853 a message sent by President Fillmore and credentials signed by Mr. Everett, then Secretary of State, were delivered to officials in Japan by Commodore Perry. The voyage from the United States to Japan occupied more than seven months.

"During these eighty-one years the physical world has been made smaller by the ingenuity of man. Science has included space in the list of its conquests. Whereas in 1853 the delivery of a message from America to Japan required months of

labored travel, today the officials and nationals of our respective nations are able to talk to each other across the world.

"It is a common observation that in the measure that people enjoy personal contact with one another, so do the barriers which separate them dissolve. This new means of communication which we inaugurate today spans the wide ocean as an additional link between our peoples. It is my hope that by furthering the interchange of ideas and of commerce which play so important a part in the relationship of states, radiotelephone service will be of great and mutual benefit to our two nations."

To Mr. Hull's remarks Mr. Hirota made the following reply:

"I am exceedingly happy to express my sincere congratulations upon the inauguration of the radiotelephone service between America and Japan and to reciprocate the spirit of cordiality in which you have just spoken.

"To meet the demand arising from the constant progress of the economic relations between our two countries, the institution of this kind of communication system across the Pacific Ocean has long been desired. The work required ardor, courage, and endurance. Today it is proper that due honor should be given to those who have achieved this difficult task which marks a new era in the good relations between our two countries.

"This occasion touches me deeply, since I can hear you personally through this apparatus. As I take my part in this friendly exchange of sentiments, I feel confident that this system of communication will prove to be a novel means for the promotion of understanding and good-will.

"Science knows no bounds in its progress. The time will soon come when telephone will work hand in hand with television, so that not only shall we hear each other's voice but also see each other's face. If this vision be translated into reality, distance would be almost annihilated, to the further en-

hancement of the intimacy which characterizes the relationship of our two nations.

"May I express again my hearty felicitations to you, and through you to the people of the United States, on the opening of this new communication service between America and Japan?"

When Mr. Hirota finished speaking he made way for Mr. Joseph C. Grew, American Ambassador to Japan, who talked informally with Mr. Hull. Mr. Hiroshi Saito, Japanese Ambassador, took Mr. Hull's place at the telephone in Washington and exchanged greetings with Mr. Hirota and Mr. Grew. The American Ambassador also talked with his daughter, Mrs. J. P. Moffatt, who was one of the guests at the Washington gathering.

At the conclusion of the Washington end of the formalities, the connection was switched to the office of Vice President T. G. Miller of the American Telephone and Telegraph Company in the Long Lines building in New York. With Mr. Miller acting as master of ceremonies, the heads of American press associations and several American correspondents of Japanese newspapers conversed with newspaper executives and correspondents in Tokyo.

Telephone service between the two countries was made available to the public on December 8.

The circuit to Japan uses the same facilities in this country as those which give service to Hawaii, the Philippines, and the Netherland East Indies. The terminals are at San Francisco and Tokyo, with short wave radio channels in the band between 18 and 45 meters bridging a distance of 5,100 miles. The area in Japan which can be reached includes the island of Hondo, which contains most of the principal cities, and Nagasaki, on the island of Kyushu, embracing in all some 380,000 telephones. All Bell and Bell-connecting telephones in the United States, Canada, Cuba, and Mexico can be linked with Japan through this new radiotelephone circuit.

Japan is the sixtieth foreign country to be brought within voice range of the United States, and the new radio channel is the seventeenth direct radio telephone circuit between American Telephone and Telegraph stations and overseas points. The Bell System transmitting station at Dixon, Cal., not far from San Francisco, focuses on the receiving station at Komuro, near Tokyo, by means of a highly directional antenna, while the circuit in the opposite direction reaches the Point Reyes, California, receiving station from Nazaki.

DEATH OF THOMAS A. WATSON

THOMAS A. WATSON died at his winter home, Passagrille, Florida, on December 13, in his eighty-first year. It was he who helped Alexander Graham Bell with the latter's experiments leading to the invention of the telephone; who made Bell's various experimental instruments, including the one which first transmitted intelligible speech; who heard Bell's voice speaking the first complete sentence ever transmitted over the telephone. With Mr. Watson's death there passes the last individual who was intimately connected with the invention of the telephone.

The following tribute by William Chauncy Langdon, Historical Librarian of the American Telephone & Telegraph Company, appeared in all the employee magazines of the Bell System:

THOMAS A. WATSON

1854-1934

To all telephone people Thomas A. Watson has represented the personal tie that bound them with the very beginnings of their great family. Now that he has gone and we consider his life as a whole, it becomes more and more clear that the title of his autobiography, "Exploring Life," was indeed the characteristic of the man throughout his eighty-one years. Born

NOTES ON RECENT OCCURRENCES

January 18, 1854, the son of Thomas R. Watson, the foreman in a Salem livery stable, and of Mary Phipps, his wife, from the beginning all paths, all ideas led out into a wonderful and unknown world. He died December 13, 1934, in the evening, at Passagrille, Florida, where so often the westering sun as it set in the Gulf of Mexico led his mind and imagination ever on into the infinity of a wonderful and glorious universe.

From the day of their marriage in 1882, indeed from the time of their first meeting, Dr. and Mrs. Watson were one in their interests, whether of work or of recreation, of education or of community welfare. Whatever opportunity opened before them, it was a path that they followed together. It was sure to lead out into new wonders, into new life. Always eager and determined to see what lay beyond, and to learn: that was the spirit of the man from childhood. And Mrs. Watson was always with him, in the fullest sense of the word, a true companion.

THE QUALITY OF HIS MIND

Young Watson was always ready for the new opportunity. As an apprentice in the shop of Charles Williams, Jr., he always kept his tools cleaned and sharpened and in order. As a young mechanic working with Alexander Graham Bell, he kept in his notebook a list of the books in the Boston Public Library that contained information about electricity with their shelf numbers, so that he need lose no time in using them for reference. When he went up to North Conway, New Hampshire, in December, 1876, and for the first time saw snow-covered mountains, he responded to the sight with all the enthusiasm with which he gave himself to work. It was the beginning of his life-long passion for mountain climbing.

It all centered in a quality of his mind, a certain precision, which accounted for his remarkable memory and made his assistance invaluable in recording and checking the history of the early days of the Telephone. Work and study and recreation alike were to him "exploring life."

It is, fortunately, unnecessary to relate the story of Dr. Watson's life. It may be read, much of it, told with all his human interest and delightful simplicity, in his autobiography. That he was the trusted assistant of Alexander Graham Bell, before, during and after the invention of the telephone; that it was he who heard the first words spoken over the telephone, and that he with his own hands made the first telephones—these facts are familiar to all telephone people. That after Mr. Bell went to England in August, 1877, he struggled on alone with the technical problems of the new communications service, is known to his successors, the telephone engineers of the present.

Though he left the telephone service more than fifty years ago, he still followed with keen interest the work of the men and women of the telephone, indeed more and more as the years went by. Every time he came to New York he asked what was being done at the Laboratories and on every one of his frequent visits to the Laboratories he showed a thorough understanding of their problems and appreciation of each new development. At the Century of Progress Exposition in Chicago last year he wanted to see everything in the Bell Exhibit in detail. It was *his* exhibit. So too with the Sesquicentennial Exposition in Philadelphia in 1926. Many a time has he expressed to me his admiration and wonder for the work of the telephone family.

HIS WIDE RANGE OF INTERESTS

Perhaps, however, there are few who realize the wide range of his interests. He did not go to school after he was thirteen years old until he was forty. Then he and his wife went together to the Massachusetts Institute of Technology. At this time he began the study of geology, which like all his other pursuits continued a life-long interest. In this he attained the recognition of professional scientists.

Returning in 1881 from a year in Europe, he started a machine shop and built an engine. Out of this grew the Fore

River Ship & Engine Company. Here occurred an outstanding instance of his predominant concern for his fellow men. In the depression of 1893 he deliberately increased his shipyards and moved down to deep water so that he need not lay off any of his men but could give work to others of "his neighbors," although he knew he was risking his business and his fortune. It was then that he built a large part of the U. S. Navy of the Spanish War.

He believed in education actively. He started kindergartens for his community and personally served on the local school board. Even in politics he thought there was good. Into the study of economic and political theory he went as an explorer, not confining himself to the traveled roads, but boldly striking across where he thought might lie the right direction. As an explorer he joined whole-heartedly the Socialist party and ran for local office on their ticket.

EXPLORATIONS IN CULTURE

As in mechanics and in business, in manufacturing and in science, so in matters of culture. What could literature and music teach him about this life? In June, 1875, when Bell tested the first telephone, Watson could not use his voice well enough for Bell to hear him. Bell started him in the cultivation of his voice, and long years since his voice and his use of it had reached the quality of a musical instrument. He used this ability to speak in public readings and lectures. Naturally, the story of the invention of the telephone told by Dr. Watson himself was in great demand. In response to this demand Dr. Watson delivered as a lecture hundreds of times to schools and other audiences the substance of his pamphlet, "The Birth and Babyhood of the Telephone."

With this study of elocution he naturally developed an intense love for literature, especially poetry and the drama. The works of Shakespeare, Robert Browning, Emerson, and Walt Whitman he knew intimately. In 1910, hearing that Frank R.

Benson, the noted English actor-manager, took students into his company, Dr. Watson applied for the opportunity, was accepted, and at the age of 56 went behind the scenes for the first time in his life. By the end of the season he was given speaking parts at the Shakespeare Festival at Stratford-on-Avon. And Benson never knew that this charming and surely eccentric American was Watson of the Telephone and the great ship-builder. Then only a few years ago he took up painting, and explored life through that art, learning to see more of the significance of life as expressed in the beauty of land and sea.

To all these he added Philosophy as the highest of his interests, and as the essence of them all. His painting was closely allied to this, for the creative light of the sun was to him a favorite illustration for the divine source of all life. Even from boyhood the metaphysical was fascinating to him. As he grew and disciplined his thinking with the positive interest of scientific subjects, he clarified his thought. Religion was to him a matter of practice rather than of theology. He kept his ideas foot-free, but religion and philosophy are closely akin. While he did his own thinking, he eagerly assimilated the thought of others. Within the last year or so, Spinoza especially was an inspiration to him. To the beatific vision of the thinker of 300 years ago Dr. Watson brought his considerable familiarity with modern science, and with his insatiable instinct for exploring life made his own progress toward the Truth.

"THE SUN SHINES BEYOND"

This tribute to Thomas A. Watson cannot close better than with what he said about the day when he received word of the passing of Alexander Graham Bell:

"The summer of 1922 marks, perhaps, the last important epoch in my life. My wife and I spent that summer in the Colorado mountains. Toward the end of our stay there, we made a long excursion without a guide through some of the high valleys and passes of the beautiful region of forests and lakes,

near Long's Peak. Mountains have always reminded me of my telephone days, probably because my first sight of them was so impressive on the notable day I spent in North Conway, New Hampshire, in December, 1876, when I talked with Alexander Graham Bell in Boston over the first long line on which we had tried the telephone.

"Those superb Colorado peaks surrounding us on our walk brought back my telephone life with strange vividness. Every incident of the walk seemed to remind me of some telephone experience. Sunshine and storm, level stretches and hard climbs, smooth trails and rough trails, the fresh energy of morning, the fatigue of evening, even the flowers by the wayside—each and all tallied something in those days of my telephone work.

"And, as if foreshadowing the final act of a drama, toward evening of the last day of our excursion a dense cloud swept down on us. It made us lose the trail and we wandered for hours without finding it, when suddenly the cloud lifted and we emerged into sunshine again with our camp close at hand.

"When we reached our cabin that cloud took on a strange significance, for lying on my table was a telegram announcing the death that morning of Alexander Graham Bell, sent me by his wife. Our walk through the mountains had been the noble prelude to the coming of that message.

"And with my sorrow for the passing of the man who had meant so much in my life came a sense of loneliness as I realized I was the last of the little group so closely and happily associated in our telephone struggles and successes nearly half a century before.

"It cannot be long before I must follow my old associates into the cloud, but I have faith that the sun shines beyond."

But in the intervening years he came to think less of the cloud and more of the sun. The glories of the sunset over the sea filled his mind. And now the sun is setting at Passagrilie.

NEW RECORDS IN OVERSEAS TELEPHONE HOLIDAY TRAFFIC

Nineteen Thirty-five's New Year greetings to foreign lands by telephone reached the highest figure in the history of the Bell System's overseas service. A total of 172 conversations were handled on New Year's Eve and New Year's Day at the foreign service switchboards in New York, San Francisco and Miami, uniting American subscribers with friends and relatives in Palestine, South Africa, Japan and many other distant lands.

The New Year's traffic brought the grand total for the two perennial peaks at Christmas and New Year's to an all-time high. During the four days comprising these holidays a total of 565 calls were completed, against 509 the year before. Four hundred and seventy of the calls were through New York, where the traffic showed an increase of 12 per cent from the record of 415 established last year.

Americans again appeared more telephone-conscious than people abroad, a majority of the calls being outward. A number of long conversations were held, one of them lasting for 40 minutes.

A large proportion of the calls across the Atlantic were to London. Paris and Rome also had a substantial number of calls. "Christmas traffic" actually began on Christmas Eve, as some American subscribers discovered upon receiving calls from the Far East, where Christmas Day arrived fourteen hours before it reached New York.

While comparatively few ships were on the high seas over the holidays, a number of calls were handled with ships. On New Year's Eve alone 27 conversations were held with the Monarch and Queen of Bermuda, Ile de France, Europa and Aquitania. Other ships which had traffic during the holidays were the Empress of Britain and the Olympic. In some cases the ships were practically in New York harbor, in others they were half-way across the Atlantic.

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NO. 2

"OTHER APPROPRIATE MEANS"

THOMAS A. WATSON'S CONTRIBUTIONS TO
TELEPHONY

THE CHANGING YEARS AS SEEN FROM
THE SWITCHBOARD

THE EFFECT OF IMMIGRATION ON
POPULATION GROWTH AND
CHARACTER

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

BELL TELEPHONE QUARTERLY

*A Medium of Suggestion
and a Record of Progress*

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IN, GENERAL, HALLS, JAILSON, OF THE CITY OF ELIZABETH
STATE OF NEW JERSEY, THOMAS G. DOUGLASS, OF THE LEGISLATIVE ASSEMBLY
DO, THAT, IN LIEU OF THE, JOSEPH R. HAYES AND AUGUST G. CONDO,
OF THE STATE OF NEW YORK, STATE OF NEW YORK, IN ORDER TO SOLICIT
DISSENT TO OTHER FOR THE PURPOSE OF LOBBYING, BURNING,
DANCING, FEASTING, OR OTHERWISE OBTAINING, LEASES OF PLACES
THEY, AND PARTLY WITHIN AND PARTLY OUTSIDE THE LIMITS OF THE
STATE OF NEW YORK, AND OF DRIPPING, URINE, SPEAKING, GOING TO
FISHING, MAINTAINING, THE SAME, AND OF RECEIVING A BODY POLITIC
AND NARRATIVE UNDER AND BY VIRTUE OF THE PROVISIONS OF AN ACT
OF THE LEGISLATIVE OF THE STATE OF

TO PUNISH, IN, TOWNS AND PLACES IS TO BE

TECTING THE BUSINESS OF THIS ASSOCIATION.

class. ToF-SIMS Analysis

AND TO BE USED IN ITS DEALINGS, AND BY WHOM IT MAY SUE AND BE
SUED, AS THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY.

THE, BY, THE PERSONS ABOVE NAMED, HAVE
DO AND SEAL THIS DAY OF
E YEAR OF OUR LORD, ONE THOUSAND EIGHT HUND-

SECOND. THE GENERAL ROUTE OF THE LINES OF THE MAP OF SAIGON. A STATION WILL BE FROM 6 KILOMETERS IN THE CITY OF

Edw. J. H. C. Jr.
J. B. Doolittle
J. T. Davis
C. J. C. S.

STATE OF NEW YORK,
CITY AND COUNTY OF NEW YORK.

ON THIS ~~thirteenth~~ ^{fourteenth} DAY OF ~~thirteenth~~ ^{fourteenth} IN THE YEAR OF OUR LORDS, ONE THIRTY EIGHT HUNDRED AND EIGHTY FIVE, BEFORE ME PERSONALLY APPEARED EDWARD J. HALL JR., THOMAS S. DOWLETTE, JENNIFER P. DAVIS AND ANGE S. DODD, TO BE KNOWN, AND KNOWN TO ME TO BE THE INDIVIDUALS MENTIONED IN AND EXECUTED THE FOREGOING CERTIFICATE OF INDIAN NATION, AND THEY PERSONALLY BEFORE ME TO ME THAT THEY EXECUTED THE SAME FOR THE USES AND PURPOSES THEREIN SET FORTH.

The fourth and last page of the Certificate. On it, beside their respective seals, may be seen the signatures of the four incorporators: Edward J. Hall, Jr., T. B. Doolittle, Joseph P. Davis, and Amzi S. Dodd.

Mrs. H. C. C. C.
 Mrs. H. C. C. C.
 Mrs. H. C. C. C.

TWO OF THE FOUR SHEETS OF THE CERTIFICATE WHICH CREATED THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY FIFTY YEARS AGO LAST MONTH. IN THE OVAL, WHICH REPRODUCES A FEW LINES FROM THE THIRD PAGE, MAY BE READ THE PHRASE WHICH PROVIDES THE TITLE FOR THE ARTICLE BEGINNING ON THE OPPOSITE PAGE.

“Other Appropriate Means”

“And it is further declared and certified that the general routes of the lines of this association in addition to those hereinbefore described or designated, will connect one or more points in each and every city, town or place in said State and in each and every other of the United States, and in Canada and Mexico; and each and every of said cities, towns and places is to be connected with each and every other city, town or place in said states and countries, and also by cable and other appropriate means with the rest of the known world, as may hereafter become necessary or desirable in conducting the business of this association.”

The “association” referred to in the paragraph just quoted was the American Telephone and Telegraph Company, and the paragraph occurs in the Certificate of Incorporation for the Company, which was executed just fifty years ago, on February 28, 1885. On March 3 it was filed and recorded in the office of the Secretary of State at Albany, N. Y. It was signed by Edward J. Hall, Jr., T. B. Doolittle, Jos. P. Davis and A. S. Dodd, who held equally the 1,000 shares which comprised the capital stock of the newly created organization.

“Other appropriate means!” What hopeful words they were! What absurd words they must have seemed at the time to almost anyone not inspired with the belief that the telephone principle discovered by Alexander Graham Bell held boundless possibilities of usefulness for mankind. And what prophetic words they seem as we read them again, remembering that the recent inauguration of telephone service between this country and Japan left only three countries in all the world with more than 100,000 telephones not united by telephone service with the United States.

In this semi-centennial year it is interesting to recall the situation that existed in telephony at the time this memorable

paragraph was written, and to sketch the dramatic story of a vision realized. Only nine years had passed since the historic moment when Bell had called "Mr. Watson, come here, I want you," and his assistant, Thomas A. Watson, in a distant room had heard the summons—by telephone. In the United States there were not more than 160,000 telephone instruments, operated by various companies that were struggling with the discouraging problem of promoting local service.

To make telephone service possible between places where local service was being given was an inevitable ambition of the telephone pioneers, and there were experiments to that end. But such experiments, when involving distances of more than 50 or 60 miles, ended in failure until the possibilities of metallic circuits and hard-drawn copper wire were discovered. When the iron wire circuit with grounded return was superseded by an all-copper two-wire circuit, the experiments met with increasing success, and in 1881 a line was opened for service between Boston, Mass., and Providence, R. I.

The usefulness, both real and potential, of this Boston-Providence line encouraged its extension through New Haven, Conn., to New York City. Various companies along its route constructed the different sections. By the time it reached New York in 1884, the necessity for similar lines to interconnect other cities was apparent. It was equally apparent, however, that the local companies themselves, occupied with their immediate local problems, could not finance, build and operate them.

So it was that the American Telephone and Telegraph Company came into being, its hopeful purpose being to provide "appropriate means" whereby "each and every of said cities . . . is to be connected with each and every other city . . . and with the rest of the known world."

The new Company's first accomplishment was the completion of a line between New York and Philadelphia which had been started by the American Bell Telephone Company. E. J.

“OTHER APPROPRIATE MEANS”

Hall, Jr., first General Manager of the A. T. and T. Company, noted in his diary for January 2, 1886:

“Six wires completed between New York and Philadelphia today.”

It was then discovered that whatever was spoken over any one pair of the wires could be heard over all pairs at the distant terminal. This “crosstalk” was corrected by installing a system for transposing or changing the positions of the wires on the crossarms at certain poles along the line—one of the earliest of the “appropriate means” developed to aid in the extension of long distance service. The diary for January 21, 1886, states:

“Tested Philadelphia wires and had excellent results. The six wires are now O.K.”

As soon as the new line reached Philadelphia, work was begun to extend it to Washington. At about the same time a line was started from New York to Albany, and the old line to Boston was reconstructed with a view to obtaining improvements in operation.

During the succeeding years the American Telephone and Telegraph Company continued building on an extensive scale. The first lines from the East reached Chicago in 1892, St. Louis in 1896, Minneapolis a year later and Kansas City in 1898. At the same time other lines were being built through the North-eastern states and branch lines were being extended from important switching points to comparatively near-by cities.

At the time when it appeared as if the limits to long distance telephone service had been reached, an important discovery made possible its further extension. This was the principle of line “loading” to reduce the amount of energy attenuation, which was demonstrated in 1900, the same year in which the A. T. and T. Company replaced the American Bell Telephone Company as the headquarters Company of the Bell System. The next year witnessed the field installations of loading coils

on long distance circuits. Their use greatly increased the range of speech transmission, and by the Fall of 1911 there were circuits from the Atlantic Seaboard reaching westward as far as Denver.

Even before the close of the century the growth of telephone plant resulting from the demand for local service had created a serious problem for telephone engineers. The congestion of wires in cities and towns had become so great that local ordinances were being passed demanding the elimination of pole lines along principal streets. Accordingly, methods were devised to place many of the wires used for local service in cable, and by 1900 the local companies were beginning to use this type of construction on an extensive scale.

While cable could be used satisfactorily for service to near-by points, the electrical energy losses involved formed a barrier to its employment in the long distance plant. By 1910, however, sufficient progress had been made in reducing the losses of electrical energy in long distance cables to enable the construction of the first telephone cable line over 100 miles long to be undertaken. Completely underground, it was routed from Boston through Providence, Hartford, New Haven, New York, Philadelphia and Baltimore. It was completed between Boston and Washington in 1914.

TRANSCONTINENTAL TELEPHONY

Just twenty years ago the first transcontinental telephone line was placed in public service. With the stringing of the final span in the new line, a 3,600 mile link of slender copper wires joined the Atlantic Seaboard with the Pacific Coast, and made voice-to-voice contacts possible within a matter of minutes.

It was an achievement that was recognized as a tremendous forward step in the development of the communications art. Impressive ceremonies marked the inauguration of the new line.

"OTHER APPROPRIATE MEANS"

In a statement made at the time, Mr. Theodore N. Vail, then President of the American Telephone and Telegraph Company, said: "This telephone line is part of the Bell System of 21 million miles of wire connecting 9 million telephone stations located everywhere throughout the United States and giving to the American people telephone service unparalleled among the nations of the earth."

With the opening of the line, a telephone service nation-wide in its extent came into being. Since then the number of telephones interconnected by the Bell System has grown from 9 million to 17 million. Transmission has been improved. Speed of service, which even as late as 1925 was twenty minutes on New York-San Francisco calls, has now been reduced to less than two minutes. When the line was opened, a three-minute conversation between New York and San Francisco cost \$20.70. Today a station-to-station call between the same points in the daytime costs \$9. After 8:30 p.m. the cost of such a call is still further reduced to \$5.50. At the same time the volume of traffic has been increasing. Even as late as 1920, five years after the opening of the service, the daily average was only twenty-one messages. Today the five transcontinental routes carry an average of about 250 messages a day to and from the same Pacific Coast points. In addition, nearly 400 messages per day cross the continent to and from points on the Coast not reached in 1920. Circuits for radio broadcasting networks and many private wire telegraph contracts are likewise provided by these lines.

With the telephone frontiers extended to coincide with those of the continental United States, the "appropriate means" were at hand to connect any Bell telephone with any other Bell telephone, in any part of the country. By 1927 the System had made sufficient progress toward it to enable Mr. Walter S. Gifford, President of the A. T. and T. Company, to state in the course of an address: "Thus today, practically any one anywhere can talk by telephone with any one else, anywhere

else in the country. Moreover, any one in the United States can now converse by telephone with any one in Great Britain, Canada, Cuba and the principal cities of Mexico. This is real progress in extent and facility of communication, but we realize we are still far from our ultimate goal."

RADIO TELEPHONY

The development of the vacuum tube as a basic element in telephone repeater systems made transcontinental telephony practicable. At the same time that experiments in its application to wire telephony were being conducted, the telephone engineers of the Bell System were also experimenting with its possibilities as an instrumentality for transmitting the human voice by wireless or radio telephony. Where physical facilities could not be provided, they hoped to send and receive speech through the ether.

The radio experiments had paralleled those bearing on the development of long distance telephone lines. A few months after the transcontinental line was opened, the first successful experiments in transmitting the human voice across oceans by "wireless" were conducted. From the United States Government radio tower at Arlington, Va., the telephone company engineers broadcast speech which was heard as far away as the Panama Canal Zone, Hawaii, and by A. T. and T. Company engineers stationed in the Eiffel Tower, in Paris.

During the third decade of the century, the war-born impetus to industry in general brought a demand for telephone service far beyond anything previously experienced. To carry out its service obligation to the public, the System drew upon its full resources in the fields of engineering, construction and operation. New developments were brought forward to meet the changed conditions. Long toll cables were designed, together with their associated repeater stations and other apparatus. Dial systems were introduced where service conditions required them. Circuits and equipment making possible

“OTHER APPROPRIATE MEANS”

network broadcasting became part of the System's steadily increasing facilities. Great advances were made in the technique of operation, which resulted in faster, better service. The original transcontinental line was supplemented by four additional routes between the East and the Pacific Coast. The toll cable joining Boston, New York, Philadelphia and Washington spread into a network covering the northeastern states and extending west to Omaha, south-west into Texas, and south into the Carolinas.

Extension of the physical facilities to the borders during these years provided telephone contact with neighboring nations. Additional lines were built northward to Canada. In 1921 three deep-sea telephone cables connecting Key West with Havana were placed in service. Six years later service was opened between the United States and Mexico.

OVERSEAS SERVICE

And eight years ago, in 1927, came another triumph of research and engineering, when the Bell System opened its telephone “gateway to the world,” through the inauguration of radio-telephone service between New York City and London, marking the beginning of an overseas communication service that now embraces sixty foreign countries and island groups.

This accomplishment in utilizing radio as an adjunct of wire telephony is a fascinating chapter in the story of the search for “other appropriate means.” It is the story of outstanding achievement in the development of many types of vacuum tubes, with a water-cooled 10-kilowatt tube to mark the progress of the evolution. It is the story of patient study of antenna systems—such as the antenna, three miles long, that is used for long-wave reception at Houlton, Maine; the curtain type suspended between lofty steel towers used initially for short-wave transmission, at Lawrenceville, N. J.; the more economical “rhombic” type later used for both sending and receiving stations and now employed in the services to Europe,

South and Central America and the Orient. It is the story of improvements in transmitters and receivers, of protective devices to insure the safety of attendants operating apparatus requiring the use of great quantities of electrical energy, of anticipating needs and preparing for them and of solving new problems as they arose in the operation of a new and spectacular branch of the telephone art.

One milestone after another was passed by the Bell System in the study of radio and its application to telephone service. The first—the successful tests carried on at Arlington—has been mentioned. Another in 1916, was the provision of “means” whereby the Secretary of the Navy, at his desk in Washington, conversed by telephone with the commanding officer of the battleship *New Hampshire*, at sea off Cape Hatteras. A third was the establishment of the first commercial radio-telephone service, which in July of 1920 linked Catalina Island, thirty miles from California, with Bell System telephones. Another was a ship-to-shore conversation between President H. B. Thayer at his Connecticut home and Captain Rind of the *S.S. America* some 400 miles from New York, in 1922.

Station WEAf, broadcasting from towers on the roof of the Bell Telephone Laboratories building at 463 West Street, New York City, was an experiment of the American Telephone and Telegraph Company on broad lines to aid in determining the Bell System’s relationship with the new industry, radio broadcasting. Completed in 1922, it operated for four years before the Company sold it to the National Broadcasting Company. During that period the technical features of radio transmission were studied while the station was in daily operation and much valuable information was learned which was applicable to radio telephony.

In co-operation with the British Post Office, which operates the telephone systems of England, Scotland, Wales and Northern Ireland, the Bell System radio engineers made preliminary

“OTHER APPROPRIATE MEANS”

arrangements looking toward the ultimate establishment of commercial radio telephone service between this country and Great Britain. By 1923 the tests had reached a point at which it was possible to carry out the first public demonstration of the service. This consisted of one-way transmission only, from New York to London. By 1926 the Post Office had completed the installation of its transmitter, and a public demonstration took place with both sides sending and receiving. The following year transoceanic telephone service was inaugurated on a commercial basis.

* * *

So much has been written concerning the extension of the territory reached by the overseas telephone service that it is unnecessary here to detail the successive steps. By the middle of 1928 a second circuit connecting the New York and London terminals, but operating on short wave lengths, was placed in service. The following year two more short wave circuits were added to the one already operating from the Lawrenceville, N. J., transmitter and the Netcong, N. J., receiver.

During 1930 the first circuit to South America commenced operating from the Lawrenceville-Netcong stations. In the same year service was opened with Australia by interconnecting the New York-London circuits with that linking London and Sidney. Similarly, in the following year Java was reached over the Amsterdam-Bandoeng channel. Early in 1931 a transmitting station for ship-to-shore service commenced operating at Ocean Gate, N. J., and replaced the experimental station at Deal. The receiving station, at Forked River, N. J., had been in service for some months. Toward the end of the same year—1931—a second South American channel from the New Jersey stations brought Brazil within reach of Bell System telephones. A few days later service was extended to Bermuda through additional equipment provided at the same stations.

New stations near San Francisco, constructed for trans-

Pacific service, brought Hawaii within voice range of the United States just in time to transmit Christmas greetings on December 23, 1931. A little less than a year later other stations were established near Miami, Fla., operating on short wave lengths and affording telephone access to countries in Central and South America, as well as the Bahama Islands.

Through the seventeen separate radio channels now operating from A. T. and T. Company stations, as well as land wires and cables to neighboring nations, overseas service today connects any Bell or Bell connected telephone with telephones in sixty countries and island groups. A summary of these countries follows:

North America—United States, Canada, Mexico.

Central America—Panama and Canal Zone, Nicaragua, Honduras, Guatemala, Costa Rica.

South America—Colombia, Venezuela, Brazil, Argentina, Uruguay, Chile, Peru.

Europe—All countries except, Russia, Albania, Greece, Bulgaria, Turkey, Estonia.

Asia Minor—Palestine, Syria.

Africa—Spanish Morocco, French Morocco, Algeria, Tunisia, Egypt, Union of South Africa.

Asia—India, Siam, French Indo-China, Japan.

Australia—Southern and Eastern portions.

Islands and island groups—British Isles, Bahamas, Bermuda, Cuba, Canary Islands, Sicily, Balearic Isles, Sumatra, Java, Celebes, Philippines, Hawaiian Islands.

Ship-to-shore telephone service is operating on a commercial basis with twenty liners regularly crossing the Atlantic or running between New York and Bermuda and the Bahamas. While several of these vessels have been on round-the-world cruises, service has been successfully maintained with them at practically all points during their voyages. In some cases,

contact was established through the Pacific Coast stations when the ships were out of range of those in New Jersey.

PROGRESS IN EUROPE

Necessarily the progress of extending the scope of overseas service is affected by the extent of telephone development in the territory to be connected. While it is true that telephone service in this country is in advance of the service abroad, particularly with respect to long distance service, nevertheless much progress has been made by the European nations, especially during the last fifteen years. The map of Europe indicates the difficulties encountered in establishing a comprehensive long distance service throughout the continent. Thirty-three nations are involved, each with its own language, currency, customs barriers; each with a telephone system of its own, made up of equipment in large part differing from that of any other system with which it was to be connected.

In an effort to overcome these and other difficulties, the leading telephone administrations in Europe eleven years ago formed the International Advisory Committee on Telephony—more commonly known as the C. C. I. F. The remarkable achievements of this body are described in an article in the October, 1934, issue of the *BELL TELEPHONE QUARTERLY*. A direct reflection of its work is found in the rapid spread of overseas telephone service throughout Europe.

Another factor aiding the progress of international telephony has been the development of short wave radio circuits in all parts of the world. As might be expected, the possibilities of short wave transmission made instant appeal to European nations with far-flung colonial possessions. Great Britain, France and the Netherlands, with Germany, have established short wave telephone channels to all parts of the world. In most cases these circuits can be interconnected with the channels serving the United States through the Bell System stations.

* * * *

At the disposal of America's telephone users there is today an instrumentality for personal communication with the far corners of the earth.

The principle was discovered June 2, 1875. Its first application to human needs was when two telephone instruments could be connected by wire and speech interchanged between the two. This was the earliest form of electric telephone communication. The first proof of limitless possibilities came in May, 1877, with the trial in Boston of the first crude switching system, for switching meant intercommunication, or the application of the principle to the needs of the many instead of the few. At the first commercial switchboard, installed in New Haven in 1878, eight lines centered and twenty-one subscribers were served. Even this primitive switching mechanism made possible only twenty-eight different connections among the eight lines.

In that is seen the telephone's destiny: not merely to connect but to interconnect, to grow in usefulness until none shall be left without the "appropriate means" for speaking one with another over the barriers of distance. In fulfillment of this destiny, switchboards grew to serve first hundreds and then thousands. This was interconnection, but only local. A company was formed to interconnect these localities and "Long Distance" was born, at first to extend the range of speech from city to city, but gradually from state to state until the nation was spanned by wire highways and there was no part of the nation which could not be interconnected with any other part. But the telephone's destiny was still unfulfilled, and even before national interconnection was a reality an international service was envisioned, was sought, was found.

As we contemplate today's agency of speech transmission, and read again the ambitions of the founders of Long Distance, the association of "other appropriate means" with world-wide telephony is inevitable. But there is far more than scope of service alone as a measure of progress. There is also

“OTHER APPROPRIATE MEANS”

the endeavor to transmit speech ever more clearly, and ever more economically. These endeavors, as well as the effort to widen the range of speech, are all activities based on the same ideal. It is enough to contrast the service of any year with the year preceding, whether involving one mile of wire or a thousand, to realize the complete significance of “other appropriate means” as this historic phrase has been understood by the American Telephone and Telegraph Company, by the Associated Companies, by the Bell Telephone Laboratories, by the Western Electric Company, in fact, by each constituent part of the Bell System.

K. T. Rood

Thomas A. Watson's Contributions to Telephony

THE last of the original group of pioneers in the telephone art passed away when Thomas Augustus Watson died on December 13, 1934, in his eighty-first year. When we speak of the present day marvels of telephonic communication, no longer can we say that the man who made the first telephone is still living. Mr. Watson's fame has been based largely on the facts that his hands made the first telephone and that his ears heard the first complete sentence transmitted electrically over a wire. To the average person, these two events overshadow somewhat his own important contributions to the development of the telephone when, after Bell's departure to England in 1877, he was the sole technician in the group who struggled to put the telephone business on its feet. It is the purpose of this review to record briefly the contributions of Watson to the telephone industry.

As a mechanic in the shop of Charles Williams, Jr., at 109 Court Street, Boston, Mr. Watson was assigned, during the winter of 1874, to make electrical apparatus for Alexander Graham Bell, a teacher of deaf persons and a Professor of Vocal Physiology at Boston University, who was experimenting in electrical devices to send more than one telegraph message over a single wire. Mr. Watson had previous experience in making electrical apparatus for others, and was considered the best of Williams' mechanics on this sort of work.

The instruments he made for Bell were transmitters and receivers for a harmonic telegraph system, whereby several telegraph messages could be sent over a single wire at the same time. As was to be expected, they were not exactly according to Bell's ideas. Bell's impetuosity led to his breaking the shop rules and making personal contact with the mechanic, so that



THOMAS AUGUSTUS WATSON.

THIS PHOTOGRAPH WAS TAKEN IN 1874, THE YEAR IN WHICH HE BECAME ASSOCIATED
WITH ALEXANDER GRAHAM BELL.

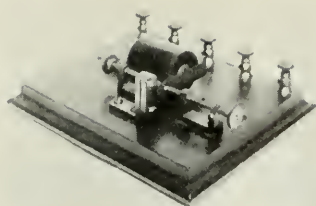


FIG. 1. HARMONIC TELEGRAPH INTERRUPTER, 1875.



FIG. 2. HARMONIC TELEGRAPH RECEIVER WITH MORSE SOUNDER CONTACT, 1875.

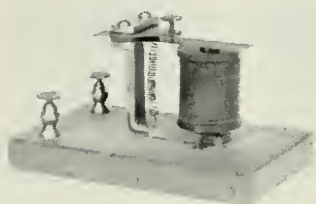


FIG. 3. HARMONIC TELEGRAPH TRANSMITTER, 1875.

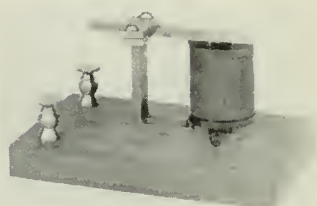


FIG. 4. HARMONIC TELEGRAPH TUNED REED RECEIVER, 1875.

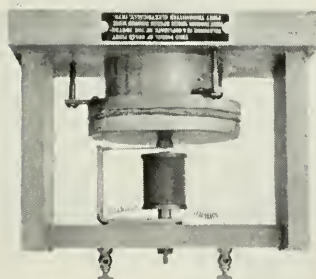


FIG. 5. FIRST TELEPHONE TO TRANSMIT SPEECH SOUNDS, 1875.

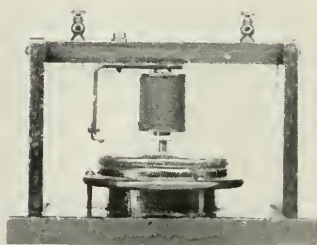


FIG. 6. ONE MODIFICATION OF THE FIRST TELEPHONE, 1875.

he might personally supervise the work. This led to more intimate relationships between Bell and Watson, who together worked over the problem that was in Bell's mind. It was an ideal arrangement, Bell with the ideas, and Watson with the mechanical ability to shape these ideas into concrete mechanisms. During this period, Watson, with his unusually alert mind, began acquiring a knowledge of electricity by home study (he left school at the age of 13) and thus laid a technical foundation for his later work.

Through the Winter of 1874 and Spring of 1875, Watson's work continued on the harmonic telegraph scheme of Bell's, and he assisted Bell with his experiments, as well as making his models. The attic of Williams' shop became an embryonic research and development laboratory. And Bell, with his typical research mind, while still experimenting with his harmonic telegraph, reasoned farther on the possibilities of the electric current and conceived the idea that if he could make an electric current vary in intensity, in the same way that sound waves in speech vary in density, he would be able to talk by electricity over a telegraph wire.

The incidents leading up to the first telephone are well known* and need not be enlarged in this article. Suffice it to say that the first "reduction to practice" of Bell's idea was made by Watson on June 3, 1875, when, following Bell's instructions, he constructed the first telephone through which speech sounds were transmitted by electricity.

Figures 1 and 2 show two models of a few of the instruments Watson made for Bell during his work on the harmonic telegraph system, and the final rather simple type of transmitter (Figure 3) and tuned reed receiver (Figure 4) used in the test of June 2, 1875, when the transmitter contact, accidentally screwed down too far, was plucked by Watson, producing an undulating current that Bell heard in the receiver

* "Exploring Life," Autobiography of T. A. Watson: "Birth and Babyhood of the Telephone"—T. A. Watson; "Beginnings of Telephony"—F. L. Rhodes.

at the other end of the line, confirming his conception of a varying uninterrupted current, which would enable one to talk over a telegraph line.

An examination of the construction of the first telephone (Figure 5) will show its apparent similarity to the harmonic telegraph transmitter: the electromagnets—coil and magnet—the same in both; a similar vibrating reed *except*, in the telephone, the end next to the magnet is hinged, and the other end is secured to the center of the goldbeater's skin diaphragm stretched over the hollow wooden cylinder forming the mouth-piece to receive the speech.

The tests with this first telephone were made in Williams' shop, over a line run from the attic down two flights to the third floor, near Watson's work bench. The receiver was the harmonic telegraph receiver shown in Figure 4. At this time, only very faint speech sounds were heard—not distinct nor articulate words. Today, however, connecting a model of this telephone through modern amplifiers, we can hear speech roar through loud speakers so as to be heard by thousands. Watson built several modifications of this instrument in an endeavor to make it talk plainer, an example of which is shown in Figure 6.

The "testing" laboratory was moved in January from the attic of Williams' Shop at 109 Court Street to a room in the attic of a boarding house at 5 Exeter Place; a second room, in the same attic, fronting on Exeter Place, was also rented by Bell, and used as his sleeping room. This was to insure more privacy of the tests than could be obtained at Williams' shop. A little later Watson moved from Salem into the remaining room in the attic at Exeter Place, which gave the two the entire attic for their experiments.

On March 10, 1876, Watson completed an improved telephone, to operate on the principle of variable resistance. A copper annunciator wire line was run from the laboratory room at the rear to Bell's bedroom in the attic at 5 Exeter Place.

On the evening of that date, Watson heard the first articulate sentence, "Mr. Watson, come here, I want you," transmitted over that line. The transmitter, and the receiver, which was still similar in design to the harmonic telegraph tuned reed, are shown in Figures 7 and 8 respectively.

During the next three months, Watson was busily engaged in making various modifications of the transmitter and receiver as instructed by Bell. Improvements were made in the first type of transmitter, as the liquid transmitter was not adapted for use outside the laboratory. Better transmission came over the improved instruments, and Bell decided to exhibit them at the Centennial Exposition in Philadelphia. These Centennial instruments, transmitter and receiver, are shown in Figures 9 and 10 respectively. Watson also made for this Exposition a group of exhibits including a harmonic telegraph transmitter and receiver and a liquid transmitter, to illustrate some of Bell's preliminary work on the telephone. The first public demonstrations of the telephone occurred during the summer of 1876 at this Exposition.

On September 1, 1876, Watson signed a contract with Mr. Gardiner C. Hubbard whereby he agreed to devote his time to the development of the harmonic telegraph and the speaking telephone, and as compensation was to receive one-tenth interest in all of Bell's patents, besides the same wages he had been receiving at Williams' Shop.

The first "outside" demonstration of a two-way telephone talk, between Boston and Cambridgeport on October 9, 1876, was made with two instruments, one at each end of the line, as shown in Figure 11. This telephone was used alternately as a transmitter and as a receiver. The illustration shows a large iron disc secured to the skin diaphragm, almost completely covering the vibrating area.

The next step was the use of a complete thin iron disc, eliminating the skin diaphragm entirely. Following this came the substitution of permanent magnets in place of the electro-

magnet, and the so-called "box" telephones came into existence. An experimental form of box telephone is shown in Figure 12; it was a single pole permanent magnet, with the coil of wire at one end, in front of which was the vibrating iron diaphragm secured to the inside of the box. Watson contributed a distinct improvement in the permanent magnet telephones when he built the magnet of four hardened steel horse-shoe plates, bolted together with a small soft iron core to carry the coils of wire clamped to each of the pole pieces. This powerful horse-shoe magnet improved the talking so much that all telephones previously made with electromagnets or single pole permanent magnets were discarded in future tests.

Watson was at the distant end, at North Conway, New Hampshire, when on December 3, 1876, Bell at Boston conducted tests over a railroad wire and the human voice was carried between points separated by more than one hundred miles. In the Spring, Bell gave numerous lecture demonstrations in various cities in the East, with Watson assisting at the other end of the line. On April 4, 1877, the first commercial telephone line was run from Williams' shop to his home in Somerville, three miles distant.

The box telephone took the form shown in Figure 13. It was used as a transmitter and as a receiver. Production at Williams' shop was speeded, and minor changes were made in the design of every lot of boxes manufactured.

At first the only method of signaling between the two telephones was by means of tapping the iron diaphragm with a pencil through the mouthpiece. This produced only a faint sound in the called telephone, and quickly resulted in damaging the diaphragm. Watson soon remedied this difficulty by designing a hammer or clapper, arranged so that when raised by pushing a button from the front, it forcibly struck the diaphragm on the base of the front of the box, instead of on the vibrating portion. This produced a loud sound easily heard at the distant called telephone. It was the first calling



FIG. 7. LIQUID TRANSMITTER OF MARCH 10, 1876.

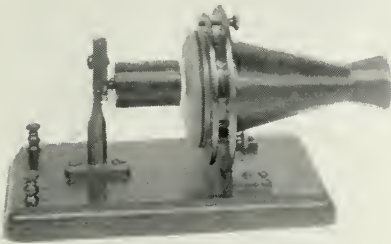


FIG. 9. TRANSMITTER EXHIBITED AT PHILADELPHIA CENTENNIAL, 1876.

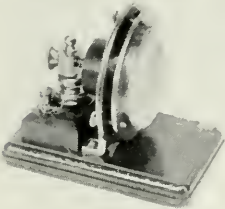


FIG. 11. TRANSMITTER AND RECEIVER USED IN BOSTON — CAMBRIDGEPORT TEST, OCTOBER 9, 1876.

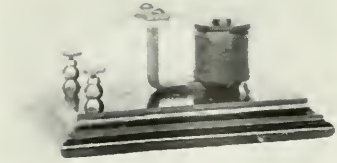


FIG. 8. TUNED REED RECEIVER OF MARCH 10, 1876.

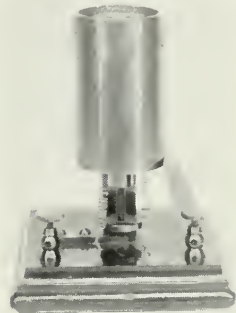


FIG. 10. IRON BOX RECEIVER EXHIBITED AT PHILADELPHIA CENTENNIAL, 1876.

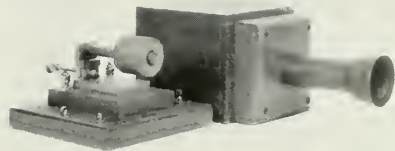


FIG. 12. EXPERIMENTAL BOX TELEPHONE WITH SINGLE POLE PERMANENT MAGNET, 1876.



FIG. 13. FIRST COMMERCIAL
BOX TELEPHONE, 1877.



FIG. 14. FIRST CALLING DEVICE,
"WATSON'S THUMPER," 1877.

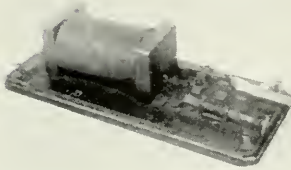


FIG. 15. CALLING DEVICE,
"WATSON'S BUZZER," 1877.



FIG. 16.
WOODEN HAND TELEPHONES.
FIRST FORM
1877.



FIG. 17.
WOODEN HAND TELEPHONES.
FOURTH FORM
1877.



FIG. 20. FIRST
TYPE OF WALL BOX
TELEPHONE, 1877.



FIG. 21. SMALL WALL BOX TELE-
PHONE FOR SHORT LINES, 1877.



FIG. 18.
RUBBER HAND TELEPHONES.
FIRST FORM
1877.



FIG. 19.
RUBBER HAND TELEPHONES.
FIFTH FORM
1877.

apparatus ever designed and used for the telephone, and was popularly known as "Watson's Thumper," shown in Figure 14. A large quantity of box telephones equipped with "thumpers" were manufactured and sold, although it was recognized that the instruments were somewhat clumsy and the signaling far from satisfactory.

This led to a device designed by Watson employing the harmonic telegraph idea of a vibrating reed, which became known as Watson's "Buzzer," shown in Figure 15. This consisted of snapping a vibrating reed between two contacts connected through the primary of an induction coil, with the secondary connected to the line. By pushing a plunger with a coil spring return to complete the line circuit, it was possible to control the impulses sent out on the line: to make interrupted calls or signals for party line service, when more than two telephones were on a line. This buzzer was also used as a calling device on the first commercial switchboard, designed by George A. Coy and installed in New Haven January 28, 1878. It was facetiously called "Coy's Chicken."

In the meantime, a separate series of experiments was being conducted in the Spring of 1877 by Bell, which resulted in constructing a light portable telephone, convenient to hold to the ear, known as a hand telephone. Its first form, appearing in May, was known as the "Butter Stamp" receiver, shown in Figure 16. The fourth form of wooden hand telephone, Figure 17, came out in June. Modifications of this hand telephone continued through the year. In the Fall of 1877, Watson superseded the wooden container with a rubber shell as shown in Figure 18, and by December the fifth form of rubber shell, with a screw cap, was developed and placed in service. This receiver was generally known as the Hard Rubber Hand Telephone (Figure 19), and with minor changes in design was in use for many years until the introduction of the double pole receiver. All these hand telephones had a straight magnet, either single or compound, and while they were used to

some extent for both talking and listening, the preferred combination was the box telephone for the transmitter, as it had the more powerful horse shoe magnet, and the hand telephone for the receiver.

The box telephones were rather bulky and costly to manufacture, and Watson re-designed them at a saving in cost of about one half. The diaphragm and coils were placed at right angles to the magnets, which greatly reduced the size and permitted the box to be mounted against the wall, instead of on a shelf. The first wall box telephone was brought out in August of 1877, and is shown in Figure 20. These, like the hand telephones, were continually modified during that year. One of the small forms, used for very short line service, such as in hotels, is shown in Figure 21. It will be noted that the mouthpiece is much smaller than in the picture of the first commercial box telephone. This was an improvement made by Watson on the large box telephones, and resulted in a greater concentration of the sound waves on the diaphragm and hence improved transmission.

In May, 1877, Bell and his associates, Gardiner C. Hubbard, Thomas Saunders, and Watson entered into an agreement with Charles Williams, Jr., to become the manufacturer of the Bell instruments for public use. During this month there appeared the first circular, over the names of Hubbard and Watson, advertising the telephone. It is noteworthy that this very first circular stated that the telephones were to be leased to subscribers, and not sold outright. Up to this time, Watson had made practically all the telephones by hand, but now this was no longer possible, and he gave orders on Williams to make twenty-five box telephones and fifty of the hand form. His time was then occupied in supervising their construction and, as mentioned above, in improving them and reducing their cost. He even went with Mr. Hubbard to Altoona, Pennsylvania, and installed two sets of telephones on a line belonging to the Pennsylvania Railroad.

On July 11, 1877, Bell married Miss Mabel Hubbard, daughter of Gardiner Hubbard, and in August of that year set sail for England, where he spent several months trying to start the telephone business in England. About this time Watson dismantled the laboratory at 5 Exeter Place, as it was too small for the increasing amount of research work required, and returned to Williams' shop for his further experimenting on the telephone and the associated apparatus. Watson was now the only person who was responsible for improvements and the design of auxiliary apparatus, to meet the demands of the rapidly growing industry; he was inventor, designer, and superintendent of manufacture. In April, 1877, only six telephones were in practical use, with little or nothing in the line of auxiliary apparatus. On November 1, 1877, three thousand telephones were leased, with the apparatus needed for their practical use.

In the latter part of 1877, Watson designed a combined fire alarm and telephone system. The fire station was automatically signaled when the door to the telephone box was opened for the use of the wall box telephone inside. A picture of this fire alarm box is shown in Figure 22.

The buzzer calling device was not entirely satisfactory on account of its screechy sound, and Watson decided that a bell that would ring without a battery was the answer. He designed a magneto generator for the alternating current, based on a magneto electric shocking machine he had previously noticed in his reading at the Public Library, and a polarized bell was created, with his ingenuity, from a polarized telegraph relay. These were placed in service early in 1878. They are shown in Figures 23 and 24 respectively. An early form of complete subscriber set first using these units is shown in Figure 25, and was known as "Williams' Coffin," from the peculiar shape of the box. This illustration shows two hand telephones, one for use as transmitter and the other as a receiver. A few subscriber sets were equipped with only one hand telephone,

but subscribers would sometimes reverse the single telephone, and try to talk with the ear and listen with the mouth! This set also shows the small switch used to cut out the coils of the bell while talking, and switching them in after the conversation was completed. Many subscribers forgot to operate the switch, so a hook for holding one of the receivers was located near the switch handle so the receiver could not be hung up unless the switch was restored.

The final combination was a wall box telephone with its powerful magnet used for the transmitter, and the hand telephone for the transmitter, shown in Figure 26. To overcome the difficulty with the hand operating switch, Watson designed an automatic spring switch which was operated by the weight of the receiver. An agent of the company in New York City, Mr. H. L. Roosevelt, also designed a similar switch at about the same time, and in the final arbitration proceedings he was awarded priority and the patent was taken out in his name. This subscriber set is equipped with this form of switch.

The rapid growth of the use of telephones from single lines into two or more stations led to the demand for switching facilities between stations on different lines. The first telephone exchange switchboard was made experimentally as early as May, 1877, and operated for a short time in the office of E. T. Holmes in Boston, Mass., but it was not until January 28, 1878, that the first commercial telephone exchange was placed in operation, at New Haven, Connecticut. The agents licensed in the various cities had experienced a growing demand for telephones throughout the Fall of 1877, so that a few manufacturers of electrical apparatus in strategic geographical locations were licensed to make telephone apparatus to relieve the pressure on Williams' shop in Boston.

In February, 1878, Watson made an extended trip through the West to induce the agents to establish telephone exchanges, and incidentally to get first hand information on the field conditions prevailing in the operation of the telephone in service.

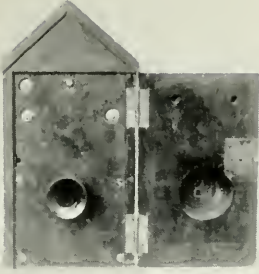


FIG. 22. FIRE ALARM TELEPHONE, 1877.

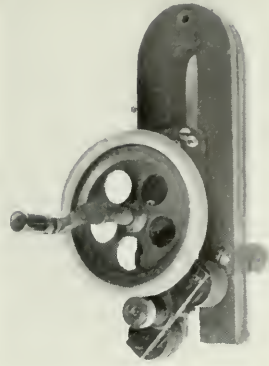


FIG. 23. HAND GENERATOR, 1878.

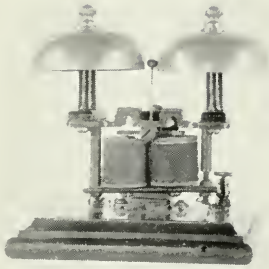


FIG. 24. POLARIZED RINGER, 1878.

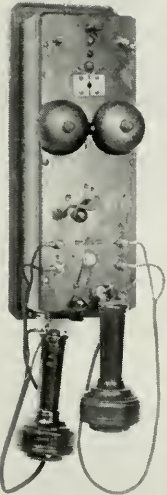


FIG. 25. EARLY FORM OF WALL TELEPHONE, "WILLIAMS' COFFIN," 1878.

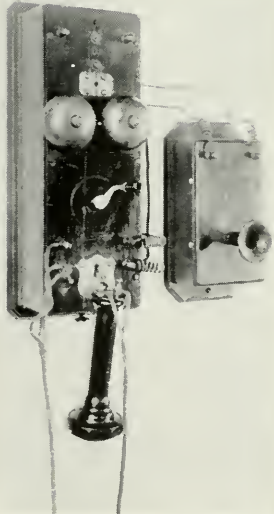


FIG. 26. "WILLIAMS' COFFIN" AND SEPARATE WALL BOX TRANSMITTER, 1878.



FIG. 27. WATSON'S PEG TELEPHONE SWITCHBOARD, 1878.

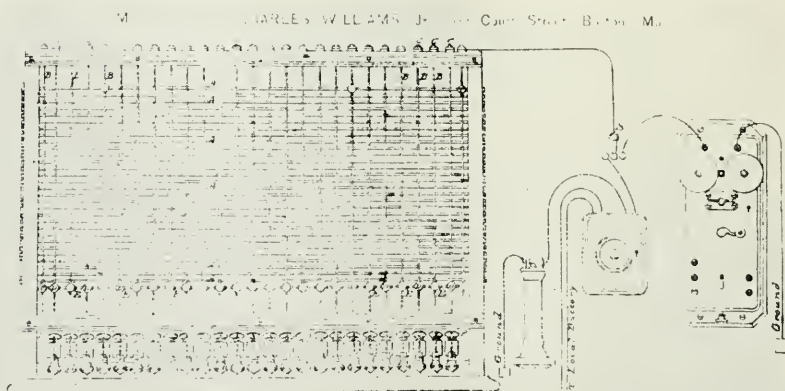


FIG. 28. "WATSON'S SLIDE SWITCH" TELEPHONE SWITCHBOARD, 1880.

This trip impressed Watson with the tremendous possibilities ahead—as well as the need for further development of the telephone and auxiliary apparatus. On his return he first made some improvements in his magneto ringer, and then devised an individual call bell, whereby only one party on a line containing several telephones would be called. His design was somewhat complicated for practical use. The ultimate solution was to put fewer stations on a line.

He next devoted his time to designing a switchboard. Watson had persuaded several of his agents to establish telephone exchanges, and consequently they looked to him to provide the equipment. One of the earliest switchboards designed by Watson is shown in Figure 27. This is the board that was installed in Philadelphia. Another was sent to Detroit, and others elsewhere. This resembled closely a telegraph peg switchboard, the several lines being connected together by brass pegs at the ends of cords, inserted between the metal discs.

Agents in cities he had not visited in February were insistent on Watson's personally visiting them to bring them up to date in the rapidly expanding business. Accordingly, on May 21st, 1878, he started on his second trip West. On the way he stopped off at Washington to interview Mr. Theodore N. Vail, then Superintendent of the United States Railway Mail Service, whom Mr. Hubbard desired to engage in the telephone business, so Mr. Watson could be relieved of all his many duties except strictly engineering work. On Watson's advice, Mr. Hubbard engaged Mr. Vail as General Manager. He also recommended to Mr. Hubbard that some agreement be made with Mr. Berliner for the use of his new loose contact microphone.

During the Spring and Summer of 1878, when not on trips, Watson spent most of his time endeavoring to develop a transmitter that would talk as well as the carbon telephone that Edison, whose inventions were being used by the competing

Western Union interests, had developed. This continued until October, when Francis Blake submitted for test a design of hard carbon button transmitter. Watson tested this in the shop and found it talked as well as Edison's, and he recommended the purchase of Blake's rights. Watson dropped his experiments on non-carbon transmitters, devoted his energies to the production of Blake transmitters, and within two months there were over a thousand in use, working even better than the Edison transmitter.

During this Summer the agents began to work out some of the simpler problems connected with their rapidly growing business, and the licensed manufacturers also began making improvements in their apparatus, as well as constructing switchboards for central offices. More and more of Watson's time was devoted to the problems presented by the agents in the field, and the routine work in the shop was turned over to men who were hired to assist him in Boston. Emile Berliner came in September, 1878, and was followed later by Anders, Henck, Jacques, Gilliland, Lockwood and many others, all of whom made contributions to the development of the communication art. Each trip to the agents in the field resulted in some new problems to be worked out by Watson and his assistants.

When the Bell Company began suit early in 1879 against the Western Union interests for infringements of Bell's patents, Watson, in addition to his regular work, spent considerable time in testifying, and in making models of the original telephones. This occurred at a most inopportune time, because of the continuously increasing number of situations in the field requiring his attention for the modification of existing apparatus and the development of new methods for switching and signaling, and of attempts to overcome line troubles. During this year and the following, in his capacities as Superintendent and Chief Engineer, he not only was the main contact with the telephone company's agents in the field, but he also supervised

the development work at the factory and contributed some important improvements on his own initiative.

Examples of the wide range of the technical consulting service rendered by Watson during this period are the two following letters:

From Theodore N. Vail, General Manager, at Boston, to Mr. H. W. Pope, in New York City, under date of June 26, 1879:

"Before putting in any exchanges or starting in or even planning for a central office system, I think it would be well for you to consult thoroughly with Mr. Watson, and examine minutely into our standard system for central office connections. What we want to do in every case is to adopt the best system, and that we think we have. Then if there is anything better we should of course want to adopt that.

"Please let me hear from you in regard to this."

From Samuel Hubbard, General Agent for Pacific Coast, at San Francisco, California, to Mr. Watson, in Boston, under date of Sept. 10, 1879:

"My agents at Oakland are very anxious to have telephonic communication with this City, and if arrangements can be made to build the line a large business can be made between the two places and intermediate stations.

"Oakland is 5 miles by water and 100 miles by land from this place. The Western Union Tel. Co. laid a cable across the bay, but it was abandoned on account of the expense of keeping in repair, too many vessels in the way. By building the line around the bay, we take in San Mateo, Redwood, Menlo Park, San Jose, San Leandro, Alameda and Oakland. At each of these places we can establish branch offices. The line can be built on the poles of the Bay Coast Telephone Company of which I am the agent. What I want to find out is, is a line of this length practicable, with all of these connections. What calls could we use, etc. etc.

"Last fall the opposition* built a telephone line of 70 miles in length for the North Bloomfield Mining Co. They are using 30 sets of telephones, Edison Carbon. They have a relay which breaks the circuit, closing a local circuit on the back stroke, which rings a vibrating bell.

*The American Speaking Telephone Company, the subsidiary of the Western Union Telegraph Company.

BELL TELEPHONE QUARTERLY

Subject: *Central Office*
W. H. FORBES, President.
THEO. N. VAIL, General Manager.
CO. L. BEADLEY, Vice President and Treasurer.
THE NATIONAL BELL TELEPHONE CO.
No. 96 Milk Street,
P. O. BOX 344.
Boston, June 26 1879.

Dear Sir.

Before putting in any
exchanges or starting in or re-
planning for a central office sys-
tem I think it would be well
for you to consult thoroughly with
Mr. Watson, and examine minutely
into our standard system for central
office connections. What we want
to do in every case is to adopt the
best system, and that we think we
have, then if there is anything better
we should of course want to
adopt that.

Please let me hear from
you in regard to this.

Yours truly,
Theodore N. Vail

A. W. Pope
699 Broadway

"WHAT WE WANT TO DO . . . IS TO ADOPT THE BEST SYSTEM."

A letter from Theodore N. Vail, in 1879, which makes reference to Mr. Watson's central office system.

WATSON'S CONTRIBUTIONS TO TELEPHONY

The Co. are not very well satisfied with the telephones or bells (the bells they purchased at \$24 each). And they have told me when their contract is out they would like to receive a bid from our Company to furnish them with telephones. I should be pleased to receive your advice on the subject.

"In the Snow Sheds of the Central Pacific R. R. Co. a distance of 40 miles there are 36 Am. Dist. Tel. Boxes on the line which are used for Watchman Signals. Telephones are used on this line at 6 stations, but they do not give very good satisfaction. They use the induction call for a signal which can only be heard at a very short distance from the instrument.

"What they want is something that will give a regular and different signal for each box, or any improvement over the present system.

"I have told the Asst. Chief Eng. who has charge of the track that I would write to you on the subject. He says they may extend their line 24 miles on one end and 35 miles on the other. The C.P.R.R.Co. are using some 75 of our telephones. I am anxious to give them any advantage.

"I am quite disgusted with our tap bell, they do not give satisfaction. I am sorry I ever put them in. The magneto bells are much the best in my opinion."

Among Mr. Watson's many improvements in apparatus may be mentioned refinements in the polarized bell and in other methods of signaling through bells on party lines, the adaptation of telephones for use in divers' helmets, the addition of a spring contact in subscriber set door hinges for more reliable connections, the first desk stand, and the use of cord pulleys or weights to prevent switchboard cords from becoming tangled. Illustrations of his contributions to operating methods include an intercommunicating system for groups of telephones in the same office building, switchboard and exchange system circuits for use in Williams' line of switchboards, and a switchboard which came to be known as "Watson's Slide Switch"—shown in Figure 28. This drawing is taken from Williams' catalog published in 1880, which also gives a complete description of its operation.*

* All of the illustrations except Figure 28 are of models or original instruments in the Bell System Historical Museum.

Induction, or crosstalk, on the telephone lines, due to electrical disturbances from neighboring telephone and telegraph lines, and also electric power lines, was a problem that baffled the early telephone workers. A step in the solution of this difficulty was the use of straight metallic circuits through the area of induced currents. A very important development of Watson's affecting the outside telephone plant was the use of the repeating coil, whereby a metallic circuit could be connected to ground circuits at one or both ends without producing noise on the metallic circuit itself. These repeating coils are an essential feature of every telephone system today, among their uses being the creation of phantom circuits and in the numerous places where it is necessary to connect unbalanced circuits to those which are balanced with respect to ground.

While a large number of Watson's important contributions to the telephone art were protected by patents, many of his ideas were adopted in the ordinary course of routine development and construction in Williams' Shop, and were not the subject of patent application. There were also quite a number of his ideas on transmitters and receivers that, while patented, were not introduced generally in the telephone business.

Early in 1881 Mr. Watson, who for seven years had carried the brunt of putting Bell's telephone on its feet, from an operating standpoint, felt the need for a well earned rest, and resigned from the telephone business. He, more than any other individual, was responsible for the growth of the telephone in its infancy, and left to others following him a husky child, which even today is continuing to grow in usefulness and service to mankind.

W. C. F. FARNELL

The Changing Years as Seen from the Switchboard

Editor's Note:

The interviews appearing under the above title in current employee magazines of the Bell System are reprinted here as affording an interesting supplement to "Opportunities for Women in the Bell System" which was published in the BELL TELEPHONE QUARTERLY for January, 1932. The first two appeared in the QUARTERLY for January, 1935.

III. WHY WOMEN ENTERED THE TELEPHONE SERVICE

"Alexander Graham Bell opened the door of opportunity for women," began Miss Laura Smith.

We started scribbling furiously. Here, we made a mental resolution, was the sentence with which we would begin the third of the interviews on the part which women have played in the development of America's nation-wide telephone service. We were about half way through the sentence when Miss Smith interrupted us.

"You needn't take that down," she remarked.

"Why not?" we protested, for we thought we knew a good sentence when we saw one.

"Because you don't have to—you already have it, right here in this binder," Miss Smith countered. "These aren't my words—though I wish they were, for they exactly sum up the situation that existed in the pioneer telephone days. No, they aren't my words—they are the words of one of those first telephone operators, and one who is very typical of all of them—Margaret Mackin (Hyatt) who began work at the switchboard in Chicago in 1883.

"Really, you know, you aren't interviewing *me*—you are personally interviewing these young women of the late Eighties and early Nineties, by proxy. You are seeing them through

my eyes. When they speak, they speak through my lips, but the words are their own—you'll find them all here in their answers to our questionnaire. If you could imagine a 'composite' telephone girl of that period, and imagine her sitting here in my office, talking to you—"

It would not have been so difficult to imagine such a young woman—one possessing the combined characteristics of all the operators who have recounted their experiences to Miss Smith and her colleagues. In their answers to the questionnaire, many of them have told at what ages they began work; some of them have described the dresses they wore on their first day at the switchboard. Practically all of them have told why telephone work attracted them; what kind of girls worked with them in the central offices; what other jobs they might have taken if they had not become telephone operators; what their duties were; what the operating rooms were like; what training, if any, was given them in order to help them do their work better or more conveniently; their hours of work, their wages—and an endless number of other things which enable one to visualize the pioneer telephone woman and to watch her as, step by step, she has developed into the telephone woman of today.

Characteristic Accents

As this composite operator speaks, there is in her voice a little of the twang of New England, a little of the soft and smoothly flowing speech of the Old South, a little of the forthright directness which one associates with the West of the frontier days, and even a subtle something which suggests the accents of the Canadian. Among the recollections of early telephone days are those of women who became operators in Boston, New York, Richmond, New Orleans, Chicago, Omaha, San Francisco and intermediate points, not to mention Montreal.

If one were to give this composite young woman an equally

composite name, it would rival the long lists of baptismal names boasted by members of the royal families of Europe. At the very least, one would have to call her Mary Katharine Frances Margaret Cecilia Viola Emma. As for her dress—

Painting a composite word picture of the dresses which these operators wore would be a complicated job for anybody, and for the writer it is all but impossible. In the interests of simplicity and accuracy, let us ask one of these women to describe herself as she looked in 1881 when, at the age of a little past fifteen, she went to work for the telephone company in Paterson, N. J.

"I wore," she confides, not without a touch of justifiable pride, "a garnet dress of cashmere, the waist of which was well boned (giving it a very delicate waist line), with small sleeves and a turnover white linen collar, fastened in front with a ribbon bow. The dress was about to my shoe tops—they were high button shoes—and my turban was made of the same material as my dress. You see, we had the ensemble idea even then. My hair was braided and pinned up around my head. No bobbed hair then—not for young ladies who were really grown up. I had worn short hair until I was ten, but now, at the advanced age of fifteen, I had put away childish things."

A Multitude of Answers

If we were to ask this composite young woman why it was that she entered the telephone service, we should receive a multitude of answers. The immediate causes which prompted these girls to become operators were almost as numerous and diverse in characteristics as were the girls themselves.

Here is one who went to work at the Nassau Central Office, New York City, in 1882. She says:

At the time, I was waiting for an appointment as a teacher in the public school, but the vacancies were few and the appointments were as a rule political preferments. There were but few other lines of work open to

young women and these were not appealing, as, for example, sales clerks in "dry goods stores" (department stores were not then in vogue).

The teaching profession lost a valuable recruit when this young woman, Miss Katherine Schmitt, became an operator. Her ability as a teacher was not, however, permanently lost. As will appear later in the present series, she became the first manager of the first operators' training school opened in the United States, or in the world, so far as can be ascertained.

Somewhat different in point of view, but hardly less typical of many other girls, was a young woman who began her telephone career in 1883, at St. Louis, Mo. In describing her entry into the service, she writes:

It was purely an accident that I sought employment with the telephone company instead of with some other concern. The only positions open to women on the outside were as salesladies or school teachers, and I did not want to be either. I had a friend who walked past my home on her way to work every morning, and I wanted to be like her—to go swinging down the street each morning to my job. She took me to the office one day, where I applied to the chief operator for a job and he (the chief operator was a man, you see) told me I could start work the next morning. Until the day I went to work for the telephone company, I had never seen or used a telephone.

Miss Smith is inclined to the belief that this young woman was a typical representative of many of her sister telephone women of that period. Some of them became operators because they had to have a job, but in the vast majority of cases, the necessity of obtaining work was not the controlling factor. Most of these girls went to work because the job was the first step toward the complete economic independence which they hoped some day to achieve. For many of them, looking for a job was in the nature of an adventure. And most of them have made it clear that they took the telephone job because there were, at the time, few other opportunities for the girl or woman without special training.

Some Other Lines of Work

"Perhaps," suggested Miss Smith, "this composite girl, who decided to become a telephone operator, had among her friends or acquaintances some girls who were working in factories or as sales clerks, or even as nurses or teachers. Perhaps she talked over her prospects with these friends. If she did, perhaps this was why she became a telephone operator. Look at these figures, most of which are gleaned from government reports covering that period."

We looked. The prospect, from the standpoint of a girl looking for a job at that time, was not exactly alluring. The average weekly wages of women workers in the Eighties, based on reports from the labor bureaus of eleven states, ran from a minimum in one state of \$5.50 to a maximum in another of \$6.68. The average for the eleven states was \$5.80. As late as 1908, the starting wages for "cash girls" in shops averaged between three and four dollars a week; for saleswomen, the average starting wage was between three and six dollars a week. In the Eighties, these averages were, of course, considerably lower. With rewards of labor such as these, the wages offered in the telephone business compared favorably, to put it conservatively. In many parts of the country, the operators were paid nothing while learning but received pay as soon as they began actual work. Most telephone companies soon put into effect regular systems of wage increases, and the upward trend of wages was at least as rapid and in many cases far more rapid than in other kinds of employment.

"But the question of wages," Miss Smith pointed out, "was not, I think, the controlling factor. These young women felt that, from a number of standpoints, telephone work offered them the best available vocational opportunity. Points which many of them tell us they considered in selecting it were: steadiness of employment, opportunities for advancement, pleasant working conditions—such as shorter hours than in

factory work and less fatigue than would have resulted from work in stores. Many of the girls found a decided appeal in the fact that telephone work offered seclusion from direct contact with the public—you must remember that these young women were pioneers in finding a place for women in the business world, and some of them approached what lay before them with marked misgivings.”

Whether or not these prospective telephone operators had discussed their plans with friends who were engaged in other lines of work, it is apparent from the data collected by Miss Smith that many of them had had heart-to-heart talks with telephone employees. Some of them had been taken by their operator friends into the central offices and were fascinated by the strange apparatus which they found there, and by the romance of this mysterious new art which enabled people to talk with each other by wire.

Influence of Telephone Friends

More than half the replies to Miss Smith's questionnaire state in one way or another that the choice of telephone work as a vocation was primarily due to the suggestion or influence of friends or relatives who were already working for the telephone company. The enthusiasm of these employees, who included both men and women, was so pronounced and they were so outspoken in telling their friends about it, that there was little difficulty, after the first few years, in obtaining operators. In fact, there were more applicants than there were positions, and many of the companies had to establish waiting lists of those who aspired to positions at the switchboard.

The First Women Operators

Many other replies to the questionnaire sent to these early operators make it clear that by the late Eighties the use of women at the telephone switchboard was a demonstrated success. All that the managers had to do, from this time on, was

to pick the best of the applicants. But it was not such easy sailing for the managers who first experimented with the heretical idea of employing women for work which men had been doing. It seems to be pretty well established that one of the first two women telephone operators was Miss Emma McNutt, of Boston, who has written that she began work "about the middle of September, 1878." Miss Mary B. Kennedy of New York was the other of the two pioneer telephone women.

"Don't you think that the managers who hired those two women must have had a good deal of courage?" we asked Miss Smith.

"I have always thought that those men were among the unsung heroes of the Bell System," was her answer. "They had no means of knowing whether those women would make good—or prove an unmitigated nuisance. There must have been among the superiors of these men some conservatives who trembled for the future of the telephone industry when the first girl operators took their places at the switchboard. There were still such conservatives, even after girls had been working as operators for some time. There was, for example, T. D. Lockwood, then an inspector for the telephone company in Boston, but later to become the Bell System's general patent attorney. He wrote in 1885 to Theodore N. Vail, then general manager of the system, a report which contained this not too optimistic view of the value of women operators:

The operators are all females, which of course has its advantages and disadvantages, which here it is unnecessary to comment on, barely mentioning the fact that, notwithstanding the pronounced opinion of resident authorities that female operators are much superior to males, the fact remains, viz: That the office manager, unless an unusually well-balanced man, is liable to form preferences, in favor of some to the exclusion of others. The young ladies also appear fond of airing their voices and sometimes prolong conversation, to talk with subscribers, again losing time. On the other hand, they exceed males in civility and general attention to their tables.

"It is easy enough to smile, now, at Mr. Lockwood's misgivings in regard to the women operators," said Miss Smith, not without a suggestion of a smile on her own part. "Of course, the girls got over any inclination they may have had toward 'airing their voices.' The adoption of standard traffic practices and uniform operating phrases eventually took care of that, as it did of a number of other difficulties. But long before the standardization of operating practices and phraseology throughout the Bell System generally, individual managers had worked out operating practices of their own which went far toward enabling the operators to do their work more conveniently and efficiently, and thus to improve and speed up the service.

The Early Managers

"They must have been a remarkable lot, those early managers. The evidence is clear that they had exactly the qualifications which Mr. Lockwood demanded of them—they were 'unusually well balanced' and they preserved a praiseworthy balance in their attitude toward the employees who reported to them. They played no favorites, and yet managed to maintain a peculiarly close and sympathetic interest in all of the operators, their personal welfare, their work and their progress. It seems to me that the foundation for the Bell System's present personnel policy was laid right then, by those pioneer managers of the telephone exchanges.

"Long before provision for sickness benefits had been adopted by the Bell System as a whole, or even thought of in many other industries, many of these men were seeing to it that no operator was neglected when overtaken by illness. Long before the well equipped dining rooms and recreation facilities of the present day had become accomplished facts, these managers were finding means of providing little comforts which made life in the central office more attractive and more wholesome.

“They were pioneers, these men who had charge of the early telephone offices—but they were pioneers in nothing so much as in the manner in which they won the respect and confidence of the women whom they supervised. You can find this fact clearly evident if you read the experiences of these first operators. Or, better still, why don’t you talk with one of these women in person? There is Miss Katherine Schmitt, of whom I spoke a while ago. For your next article, why don’t you ask her to tell you about the early switchboards, the development of operating practices and of training schools, and other points on which she has first hand information? Get her comments on what these other operators have written about their experiences. But before you do that, just ask her what she thinks of the managers of those first years of the telephone service—she ought to know, and I can guarantee that she will tell you just what she thinks.”

A few days later, we talked with Miss Schmitt. Her dark eyes snapped as we read her the phrase from that report of long ago which pointed out the possibility that the central office managers were “liable to form preferences.”

“Well—did they?” we asked.

“Never, so far as I could see,” Miss Schmitt replied, without a second’s hesitation. “I think I would have seen it if it had been there—I usually knew what was going on in the office. No, there were never any favorites—either in the early days or later on. They took a personal interest in us—all of us. That’s what made the job run smoothly. It did more than that—it was, I think, the basis for one of our Bell System traditions.

“You know, we hear a lot about the ‘Spirit of Service’ of the telephone operator. She has it, all right, and she had it in those early days. But I think the loyalty of the operator was reflected, as a mirror reflects light. It really came from the men who managed those central offices. You just couldn’t

be anything but loyal to your job and to the public when you were working for—or rather working *with*—men of that sort.”

IV. SOME EARLY SWITCHBOARDS

One of the marvels of the telephone lies in what the telephone is—an almost universally accepted instrumentality of communication which, by means of a far-flung system of electrical facilities, provides a peculiarly intimate bond not only between individual and individual, but between nation and nation. But another marvel of the telephone lies in the fact that it has become what it is in so short a space of time. Less than sixty years ago the telephone art existed only as an unfulfilled hope. The man who heard the first sentence spoken over a telephone wire died but a few months ago. The history of the telephone covers a span no longer than the lives of many persons now living.

One cannot but be profoundly impressed by the significance of these facts if one is fortunate enough to talk with such a person as Miss Katherine Schmitt, of Brooklyn, who was one of the Bell System's early telephone operators. Keen of mind; with a memory which provides an almost photographic record of the events of those first telephone years; bright of eye, ready of speech—such a personality brings forcefully home to one the fact that, relatively speaking, these events happened “only yesterday.”

Nor is Miss Schmitt an exceptional example of these pioneer telephone operators. One could find them in widely scattered cities and towns throughout America—women, who, despite advancing years, have kept a remarkably clear mental picture of their first days in the telephone service, and who retain an almost girlish enthusiasm and zest for the part in this service which it was theirs to play.

We had wanted to supplement the material collected by the Personnel Department of the American Telephone and Tele-

graph Company in answers to a questionnaire sent out to some two hundred of these pioneer telephone operators. We had wanted something a little more personal than the written word, albeit many of these trail-blazing operators had given a peculiarly intimate account of their life at the switchboard. We had asked Miss Schmitt if she would tell us something of the apparatus which served as a switchboard when she went to work in the Nassau Central Office, New York City, in 1882, and comment on the experiences of some of her sister operators in other cities. We had asked her particularly to picture for us the training methods, such as they were, that were used during her first years of service, and to comment on her experience with the subsequent development of methods of instruction—in which development, as will be seen in the next installment of this series, she played an important part.

Switchboards of Many Strange Sorts

“What about your switchboard, and what did you do when you wanted to connect one subscriber with another?” we asked, by way of beginning.

“Well, it wasn’t a switchboard, in the first place—not in the modern sense. We called them switchboards, to be sure, but I am afraid that their recognition as such would be a hard job for the operator of today, who is accustomed to the multiple, common battery boards, with electric light signals. If you run through the records by these other early operators, you will see that there were almost as many kinds of switchboards as there were central offices. There were—”

May we interrupt Miss Schmitt at this point, before she is well started, to remark that we were well aware of the multiplicity of switchboard designs with which the struggling Bell companies were then trying to provide service? And thereby hangs a tale of one of the interesting phases of telephone development.

Theodore N. Vail had but recently joined the Bell organization and, from its office in Boston, was attempting to guide the development of the new business as best he could. The Bell Company had few facilities for experimentation and none for centralized manufacture. This condition resulted, as Dr. Frank B. Jewett has said, in a state of things in which "every little shop equipped to manufacture telephone apparatus immediately entered the field of production and applied the inventive genius of its own staff to the task of development."

Yet this development was not quite so chaotic as it seemed. Behind it there was a fundamental principle which Vail had laid down in a letter to H. W. Pope, written in June, 1879, which has become one of the historic documents of the telephone service. In it he had said: "What we want to do in every case is to adopt the best system, and that we think we have. Then if there is anything better we should of course want to adopt that."

Improvements, or what were believed to be improvements, were being made in dozens of places all over the country. The name of switchboard inventors was legion; the types of switchboard even more numerous for many types were put out under the name of the same designer or manufacturer. There was one Law type board, used in Richmond, Va., among other places, which was pyramidal in shape. Another Law type board consisted of a square table, on which connections were made by sticking pegs into holes on its surface. When traffic was heavy, the operators who sat at such a table gave somewhat the impression of a particularly fast and furious game of cribbage—with the cards left out.

There was the Gilliland board, which had something of the appearance of the modern switchboard, but which on close examination more nearly resembled an old-fashioned parlor organ. Later, there was a board which, because of a depressed trough behind the keyboard, which permitted mounting the

line signals below the plug shelf, was known by the expressive if not elegant name of the "hog-trough" switchboard. There were many others—but why continue? Let us ask Miss Schmitt to go on with her interrupted description of the equipment in the old Nassau office, as it was in 1882.

How One Central Office Looked

"Our office," Miss Schmitt explains, "consisted of a long, narrow room with apparatus at each side. At the middle of one end of the room stood the manager's desk. On one side was what we called the 'case.' Here, drops bearing the subscribers' numbers, in groups of 100 or fractions thereof, were arranged on upright panels. The case operator received the incoming calls, but did not complete them. The subscriber rang in by turning a crank, and the annunciator associated with his line dropped. The case operator took from him the number he wished to call, wrote it on a slip of paper, which she stuck on a pin-file conveniently placed on the board. These slips were collected by messengers, who carried them to the "trunk table" operators. The trunk tables were what their name implied—tables at which trunk lines were terminated. Each table was about the size of a present-day sewing machine and was equipped with eight or ten brass strips, each strip being the termination of a trunk line. To enable the operator to connect with a trunk, a brass plug attached to a cord was provided. This plug was held in the operator's right hand, and the receiver in the left—we had no headsets in those days. In making a connection, the plug was passed under the trunk strip, thus raising the strip and connecting the plug with the trunk. The great feat, however, was to connect the subscribers' lines with the trunk lines. When I first went to work in the old Nassau office, and for some time afterward, boys known as switchmen were employed for this purpose.

"When the trunk table operator received a ticket from the case operator, she proceeded to connect the calling subscriber

with the trunk line to the called office. This she did with the assistance of a switchman, to whom she passed the call—as, for example, ‘463 on 41.’ On the board in front of the switchman all local lines were terminated, so that he could switch the calling subscriber’s line to the line of the called subscriber or, in the case of a call to an outside office, to a trunk, as directed by the trunk table operator.

“When the trunk table operator found that the conversation was completed, she cleared the connection by calling out ‘Clear 41.’ When he was not busy doing something else, which he generally was, the switchman then disconnected the two lines. If the switchman’s response to the requests of the operator was not reasonably prompt, she had to repeat it, in louder tones. Life in a central office in those days was a case of the ‘survival of the fittest’—the operator with the most lung power got things done.”

Miss Schmitt’s description of the switching apparatus at which she made her telephone debut tallies quite closely, in essentials, with those of other operators who at the same time were working in Boston, Chicago and other cities. The Chinnock switchboard was installed in the Nassau office, in New York, in 1879, but had undergone some changes by 1882, when Miss Schmitt became an operator. The Williams board was used in New England, the Gilliland and Post boards in the Middle West, but also in New England and in Canada, and the Law boards in the South and Southwest.

On the Gilliland, Post and Williams switchboards, the connections between lines were not established by means of cords and jacks, as was the case with the Chinnock board described by Miss Schmitt and all later switchboards, but rather by brass plugs inserted in rows of crossing metallic strips or lines laid out in checkerboard fashion.

In 1880, the Western Electric Manufacturing Company brought out what was known as the “Standard” switchboard,

which in design and general arrangement was a forerunner of the boards later adopted throughout the Bell System. The switchboard described by Miss Schmitt, however, seems to have marked a partial advance toward the present-day manual switchboard, in that its "case" was similar, in purpose and function, though not in form, to the modern "A" board, while its "trunk table" was an embryonic form of the "B" board of today.

Steps in the Switchboard's Evolution

Other steps in the evolution of the modern switchboard included such outstanding developments as that of the multiple board, the first complete installation of which was made in 1882; the use of the metallic circuit and the adaptation of switchboards to it, which began in 1887; the introduction of the common battery principle, first applied to a multiple board in 1896; and the use of incandescent electric lights, instead of annunciators, for signaling purposes, which was inaugurated in 1894. All of these steps, Miss Schmitt and many other pioneer operators personally witnessed as they were taken—witnessed, and took part in them, for though scientists and engineers planned these improvements in apparatus and put them into effect, it was the woman at the switchboard who gave them their final stamp of approval. If she had not been able to operate them successfully, they would have been flat failures.

"You see," says Miss Schmitt, "as one looks back on all these years of switchboard development, from the operator's standpoint, one sees that they were intended for just one primary purpose—to make it possible for the operators to do their work more easily, more quickly and more accurately. It was a part of the Bell System's policy of giving the best possible service it can give. But it was also part of its policy—and I think it is an equally fundamental policy—of making it possible for its employees to give the best there is in them to the service.

Call it 'giving the operators a fair break' or what you will, it was a policy to which we responded. The more convenient the apparatus which we were given to work with, the better we worked. The more efficient it was, the more efficient we became."

"Not without being taught, did you?" we asked, for we were anxious to hear what Miss Schmitt had to say about early methods of training operators for their work.

But that, as Kipling might say, is another story.

R. T. BARRETT

(To be Continued)

The Effect of Immigration on Population Growth and Character

A THIRD of the population of the United States are immigrants or the children of immigrants. Naturally any changes which affect this class of people have a profound influence upon the growth and characteristics of the population of the country, and are of interest to the telephone industry in connection with appraisals of the potential demand for its facilities and services.

Since the World War the interchange of peoples between countries has been vastly altered. The stream of immigration to the United States has diminished to a mere trickle; today deportations and voluntary departures actually exceed arrivals, apparently for the first time in our history. Furthermore, our attitude toward the alien has changed from one which welcomed him with open arms on the assumption that our shores offered an asylum to the oppressed of the earth, to one which discourages his coming almost to the point of complete prohibition. An understanding of these and related changes is essential to any consideration of the future composition of the population of the country.

HISTORICAL REVIEW OF IMMIGRATION

During our national history, governmental agencies have recorded about thirty-eight million immigrants admitted through regular channels, while perhaps as many as five million additional foreign-born entered this country in times when alien movements were either imperfectly counted or not recorded at all, particularly migrations over our land borders. The five million would also include a small allowance for aliens who entered illegally.

During the first hundred years of our history as a nation, immigration was free from legal restrictions; in fact, in the initial four decades no attempt was made even to count the incoming aliens. Following this, for forty years the only restrictions imposed were of a qualitative nature, designed to exclude certain undesirable classes. However, the past fifteen years have reflected a definite attitude toward restricting the admission of foreign-born on a numerical basis, and this policy has been more pronounced since the beginning of the depression.

Until this recent period when quantitative restrictions became effective, the flow of immigration was largely influenced by economic conditions here and abroad. The first really notable influx occurred about 1850 and was due largely to famine in Ireland and to political revolution in Germany. Successive waves of immigration tended to increase in volume; they reached peaks of 1,285,000 in 1907 and 1,218,000 in 1914, with troughs during the Civil War and the depressions of the 'seventies and the 'nineties. The World War practically closed the flood-gates in Europe until in 1918 immigration declined to the lowest level since 1862. Since 1921 the volume of European immigration has been controlled by our restrictive policy and variations in immigration other than that from quota countries were due entirely to movements from Canada and Mexico. Actually the heavy migrations from Canada and Mexico to the United States from 1920 to 1930 were merely part of the general rural to urban movement which took place all over the country during that decade.

During the first century of our immigration history, the great bulk of immigrants came from the United Kingdom and Germany; the countries of northern and western Europe furnished over 70 per cent of the total immigration as late as 1882. From that time until the World War an increasing proportion of immigrants came from southern and eastern Europe, until

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they accounted for over three-fourths of all immigration and four-fifths of the number from Europe.

During the past 27 years as a whole, emigration has amounted to about one-third of total immigration and, with the exception of a few years when unusual conditions prevailed, it has not varied much year by year from this relationship to the inward movement. No governmental data on emigration are available prior to 1908, but steamship company records of the outward movement of aliens indicate that it was of minor importance.

IMMIGRATION LEGISLATION AND POLICY

The first inclusive Federal immigration law was enacted in 1882. It denied admission to lunatics, persons likely to become public charges, convicts (except those convicted of political offenses), and the Chinese race. There was later added to the excluded classes the natives of other Oriental countries, physical defectives, criminals and immoral persons, contract laborers, and illiterate aliens. All these restrictions, however, were primarily qualitative and did not affect the numerical influx of the foreign-born.

The passage of the per centum quota law in 1921 marked the beginning of a policy which restricted immigration on a numerical basis. This law provided that "the number of aliens of any nationality who may be admitted under the immigration laws to the United States in any fiscal year shall be limited to 3 per cent of the number of foreign-born persons of such nationality resident in the United States, as determined by the census of 1910." This limited the total number of quota immigrants from Old World countries to 357,800 per year. Aliens were exempt from the quota provisions after one year's residence (raised to five years in 1922) in a country of the New World.

Nationality under this law was determined by country of birth, and each country had its own quota. Countries of

northern and western Europe which, during the period immediately before the passage of the law, had been furnishing only about 20 per cent of the immigration from Old World countries were given quotas aggregating 55 per cent of the total. The law thus represented not only a radical change in our immigration policy in regard to the number which could be admitted, but was a deliberate attempt to confine our immigration largely to those nationalities which were considered most assimilable.

The Immigration Act of 1924 supplanted the so-called quota limit act of 1921 and included several important changes. The annual quota of each Old World country was immediately lowered to 2 per cent of the population of such nationality resident in the United States in 1890 instead of 3 per cent of that in 1910. The total of all quotas under the Act of 1924 amounted to 164,667, a reduction of about 193,000 from the number admissible under the Act of 1921. Most of this reduction occurred among aliens native to southern and eastern Europe. Another change provided that the quotas should apply to natives of Old World countries residing in American countries regardless of their length of residence there. Otherwise the classes exempt from the quota were about the same as those under the 1921 law.

The Act further provided for a determination of the national origins of the population of the country as of 1920 by specifying that "the annual quota of any nationality shall be a number which bears the same ratio to 150,000 as the number of inhabitants in continental United States in 1920 having that national origin bears to the total number of inhabitants in continental United States in 1920; but the minimum quota of any nationality shall be 100." The effect of this provision, which became effective on July 1, 1929, was merely to change somewhat the quotas without changing the general working of the immigration law. The decreases in quotas were largely cen-

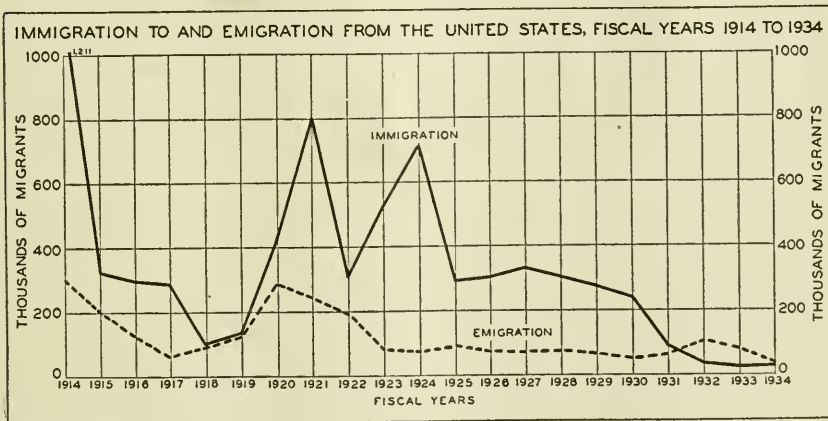
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tered in northern continental Europe and Ireland and the principal increases occurred in Great Britain.

The Immigration Act of 1924 introduced a radical departure from the previous immigration policy in providing that American consuls, assisted by technical advisers of the Immigration Service, should examine abroad prospective immigrants under all provisions of law, and refuse visas to those deemed inadmissible. The inauguration of this practice permitted a certain degree of selectivity of aliens in their home countries, resulting in a higher standard of quality and a smaller percentage of rejections than previously. Moreover, when the economic depression came along this practice facilitated the enforcement of the provision designed to safeguard the United States from immigrants who might become public charges.

VOLUME, SOURCE, AND CHARACTER OF RECENT IMMIGRATION

Many of the most striking changes in the immigration tide have taken place during the past two decades and in the following discussion principal attention will be directed to the more important aspects of the alien migrations of this period.



The accompanying chart discloses several significant facts concerning the trend of immigration and emigration during the

past twenty years, notably the relatively large outward movement during the early years of the World War, which included many who went to join the colors of their respective countries; the sudden increase in both immigration and emigration following the armistice; the sharp decline of immigration in 1922 resulting from the quota limit law; the revival of immigration in 1923 and 1924 (largely from Canada and Mexico) and the remarkable decline in emigration; the drastic drop in immigration in 1925 resulting from the new quota limit law; and, finally, the further sharp reduction in immigration since 1930 to a point where emigration has exceeded immigration since 1931. During recent years the strict interpretation of the provision of the immigration law requiring the exclusion of persons "likely to become a public charge" has greatly reduced the number of consular visas issued to prospective immigrants.

One element frequently overlooked in ordinary calculations of population movements is the migration of United States citizens who permanently depart this country. This population loss has amounted to over 600,000 during the past seventeen years and probably would more than offset any gains from illegal entrants in this period. A small proportion of this number (11 per cent) were naturalized citizens but the great majority were native born, mostly children of foreign-born parents who accompanied the latter when they emigrated to some foreign country.

Owing to the changes in the boundaries of various countries and the creation of new countries resulting from the World War, it is impossible to make satisfactory comparisons between post-war and pre-war immigration from Europe on the basis of country of origin. Table 1, however, presents some interesting comparisons between immigration from specified sections of Europe and from other sources in the fiscal years 1914, a fairly normal pre-war year in the matter of immigration into the United States; 1921, a post-war year during which

there was no numerical limit on European immigration; and subsequent years when various quota limit laws were in force. It will be noted that in 1914 and also in 1921 a large majority of our immigrants came from southern and eastern Europe. On the other hand, the contribution of northern and western European countries, while numerically greater than in any post-war year except 1924, was only 13.5 per cent of the total in 1914 and 17.2 per cent in 1921 as compared with an average of 35 per cent for the following 10 years. The increased volume of immigration from British North America and Mexico during the period of European restriction is also a noteworthy feature.

The effect of the quota limit laws of 1921 and 1924 on European immigration will become more apparent when the permissible and actual admissions under the restrictive legislation, as shown in Table 2, are examined. It should be borne in mind that in the quota law figures, country of birth rules, whereas country of last permanent residence is regarded as country of origin in ordinary immigration tables. Thus, immigrants admitted as Canadian residents who were born in England would be charged against the quota allotment for Great Britain. This provision, together with the fact that the quota limit laws contained a good many exceptions under which applicants could be admitted in excess of allotted quotas, accounts for the seeming inconsistency of the number of quota immigrants admitted from northern and western Europe from 1925 through 1931, as shown in Table 2, exceeding the corresponding number in Table 1.

In the five-year period following the passage of the 1924 quota, more than 92 per cent of the number allotted to all the principal European nationalities actually came to this country. And, as indicated in Table 2, the proportion admitted in the fiscal year 1930 under the national-origins plan did not differ much from the average of the five preceding years, the lower quota allotment under the 1929 law accounting for

TABLE 1
IMMIGRANT ALIENS ADMITTED, BY PRINCIPAL SOURCES, IN FISCAL YEARS SPECIFIED

Source	1914	1921	1922	1923	1924	Average 1925-1929	1930	1931
Northern and Western Europe*	164,133	138,551	79,437	156,429	203,346	121,828	97,118	34,719
Southern and Eastern Europe*	894,258	513,813	136,948	151,491	160,993	36,053	50,320	27,190
British North America.....	86,139	72,317	46,810	117,011	200,690	84,487	65,254	22,183
Mexico.....	14,614	30,758	19,551	63,768	89,336	48,634	12,703	3,333
Other Countries†.....	59,336	49,789	26,810	34,220	52,531	13,180	16,305	9,714
Total.....	1,218,480	805,228	309,556	522,919	706,896	304,182	241,700	97,139

* Northern and western Europe comprises Belgium, Denmark, France, Germany, Iceland, Luxembourg, Netherlands, Norway, Sweden, Switzerland, and England, Ireland, Scotland, Wales, and United Kingdom not specified. Southern and eastern Europe comprises the other countries on that continent.

† Includes Central and South America, Africa, Asia, Australia, Atlantic and Pacific Islands, and countries not specified.

TABLE 2
IMMIGRATION QUOTAS ALLOTTED TO SPECIFIED AREAS AND THE NUMBER OF ALIENS ADMITTED AND CHARGED AGAINST SUCH QUOTA ALLOTMENTS, IN FISCAL YEARS SPECIFIED

Country or Region of Birth	1921 Quota Law		1924 Quota Law		National-Origin Plan		
	Number Admissible Annually	Number Admitted 1924	Number Admissible Annually	Average Number Admitted 1925-1929	Annual Quota	Number Admitted	
						1930	1931
Northern and Western Europe.....	197,630	197,598	140,999	131,690	125,853	114,157	37,629
Southern and Eastern Europe.....	155,656	155,527	20,323	19,354	24,638	24,576	14,668
All other countries.....	4,517	4,517	3,345	1,278	3,223	2,764	1,821
Total.....	357,803	357,642	164,667	152,322	153,714	141,497	54,118

EFFECT OF IMMIGRATION ON POPULATION GROWTH

practically the entire difference in numbers. As a general rule, the large countries of northern Europe, such as Great Britain, Germany, and Ireland, have not come quite so near completing their quotas as have the smaller countries or the nations of southeastern Europe.

The fiscal years 1930 to 1934, inclusive, witnessed a drastic reduction in the volume of immigration. A more strict administration of the law was adopted in September, 1930; and the clause relating to the danger of becoming a public charge was interpreted so that the entrance of members of the working class was made almost impossible.

Another interesting form in which immigration statistics appear is the classification according to races or peoples. Since this record is based on the racial rather than the political or geographical status of admitted aliens, it is not affected by shifting political boundaries, newly created countries, or changed place of residence on the part of the aliens themselves. Moreover, several distinct racial groups often form the native population of individual countries, as, for example, Russia, where the racial composition of the immigrants who came to the United States during the five-year pre-war period, 1910-1914, was distributed according to the following percentages: Hebrew 36.6, Polish 33.9, Russian 14.5, Lithuanian 9.7, and Finnish 5.3.

Table 3 shows, for the principal racial groups, the number of immigrant aliens admitted to the United States during selected years. In 1914, a fairly typical pre-war immigration year, three-fourths of the immigrants admitted from all sources were of the varied stocks indigenous to southern and eastern Europe, and only one-fifth belonged to northern and western European peoples. In 1921, the first post-war year to witness a resumption of immigration to any considerable extent, the corresponding proportions were two-thirds and one-quarter. However, under the operation of the quota laws these ratios

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TABLE 3
IMMIGRANT ALIENS ADMITTED DURING SPECIFIED YEARS, BY RACE OR PEOPLE

Race or People	1914	1921	1924	Average 1925-1929	1930	1931
<i>Northern and Western Europe</i>	253,855	206,995	393,342	204,251	161,444	56,354
English*.....	51,746	54,627	93,939	39,680	34,960	12,703
French*.....	18,166	24,122	48,632	19,942	13,771	4,908
German.....	79,871	24,168	95,627	55,853	34,415	13,813
Irish.....	33,898	39,056	42,364	39,795	34,947	10,814
Scandinavian.....	36,053	25,812	40,978	19,378	8,478	3,947
Scotch.....	18,997	24,649	61,327	25,090	28,117	7,618
All Others (Dutch, Flemish and Welsh).....	15,124	14,561	10,475	4,513	6,756	2,551
<i>Southern and Eastern Europe</i>	901,659	521,474	187,709	42,286	56,604	31,598
Balkan races†.....	154,061	63,338	23,389	5,632	6,938	3,309
Greek.....	45,881	31,828	5,252	2,177	3,793	2,663
Hebrew.....	138,051	119,036	49,989	11,232	11,526	5,692
Italian.....	296,414	222,496	59,209	14,604	23,316	13,970
Magyar.....	44,538	9,377	7,446	1,093	1,542	999
Polish.....	122,657	21,146	19,371	3,670	4,924	2,008
Russian.....	44,957	2,887	9,531	1,203	1,634	967
All Others (Finnish, Lithuanian, Portuguese and Spanish).....	55,100	51,366	13,522	2,675	2,931	1,990
Mexican.....	13,089	29,603	87,648	47,705	11,915	2,627
All other races and people.....	49,877	47,156	38,197	9,940	11,737	6,560
Total.....	1,218,480	805,228	706,896	304,182	241,700	97,139

* Includes considerable numbers entering United States from Canada.

† Natives of Czechoslovakia, Bulgaria, and Yugoslavia including Bohemian, Bosnian, Bulgarian, Croatian, Dalmatian, Herzegovinian, Montenegro, Moravian, Serbian, Slovak, and Slovenian.

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were reversed, and since 1921 the peoples native to northern and western Europe have been greatly in the majority.

In fact, one of the most significant effects of the quota laws has been the greatly increased proportion which the English speaking peoples—English, Irish, Scotch, and Welsh—formed of the total number of immigrant aliens admitted during the latter part of the 1920–1930 decade as compared with the pre-war period. In 1914 only 9 per cent of the total immigration was composed of English speaking peoples, while by 1924 this proportion had increased to 28 per cent; and for the five-year period 1925–1929 it averaged 35 per cent, finally reaching 42 per cent in 1930.

THE NET RESULT IN POPULATION GROWTH

During the past two decades the foreign-born population increased by only 688,000, or 5 per cent, as compared with 4,266,000, or 46 per cent, during the 1890–1910 period. Expressed in different terms, the foreign-born contributed only 2 per cent of the total population growth between 1910 and 1930 as against 15 per cent during the preceding 20 years.

Since the 1930 census a net outward migration of foreign-born has taken place, amounting to about 100,000 in this five-year period. Furthermore, with net immigration at a comparatively low average level during the last twenty years, the majority of our alien population is now becoming well advanced in years, and consequently its total death rate is high. (Table 4 shows how much the average age of the foreign-born increased between 1910 and 1930.) It is believed that the combined losses in foreign-born population during the present decade from net emigration and deaths should amount to about 3,500,000, thereby reducing its proportion of the total population from 12 per cent in 1930 to 8 per cent in 1940.

Associated with the increasing age of the foreign-born is the declining birth rate. The 1930 census showed 1,500,000 fewer children under ten years of age of foreign parentage

than did the 1920 census. This slackening in the increase in the second generation of foreign white stock is clearly indicated by the figures in Table 4 which show that this population group in 1910 was younger than the native white of native parentage, but was distinctly older than the latter in 1930.

TABLE 4
PERCENTAGE DISTRIBUTION OF POPULATION BY AGE; 1910, 1920 AND 1930

Age Group	Native White of Native Parentage			Native White of Foreign or Mixed Parentage			Foreign Born White		
	1910	1920	1930	1910	1920	1930	1910	1920	1930
Under 5 years.....	13.2	12.6	11.3	14.1	13.1	7.7	0.8	0.3	0.2
5 to 14 years.....	22.6	23.0	22.6	24.1	24.4	21.2	4.9	3.6	2.0
15 to 24 years.....	19.7	18.5	19.0	21.6	18.8	21.0	15.8	10.7	7.4
25 to 44 years.....	26.2	27.0	27.2	27.6	27.1	29.3	44.1	45.7	41.8
45 to 64 years.....	13.6	14.1	15.0	11.2	14.3	16.3	25.4	29.8	36.1
65 and over.....	4.6	4.8	4.9	1.4	2.3	4.5	9.0	9.8	12.5

Even among the foreign-born population there are pronounced differences in rates of growth, especially among the natives of European countries. For example, it appears from Table 5 that the proportion of foreign-born and their children from the "old" immigration countries—principally Germany, England, Ireland, and Scandinavia—is still decreasing, notwithstanding the fact that movement from these countries is favored by the new quotas. This is due to the fact that the large proportion of these nationals have been in this country so long that their death rate is high. On the other hand, there is a lower death rate in the more recently arrived groups (from southern and eastern Europe) which for the present compensates for their decreased proportion of quota immigration. Another decade of restricted immigration will, however, probably destroy this differential.

The older immigrant groups naturally increase more slowly than the more recent arrivals who include a larger proportion of young people and who also are from countries with a higher

EFFECT OF IMMIGRATION ON POPULATION GROWTH

TABLE 5
FOREIGN BORN WHITE STOCK IN THE UNITED STATES, BY REGION OF BIRTH OR ORIGIN; 1910, 1920 AND 1930

Region of Birth or Origin	European Born White Population			Native Whites of European or Mixed Parentage		
	1910	1920	1930	1910	1920	1930
<i>Europe</i>						
Southern and Eastern (New).....	5,238,495	6,363,022	6,407,272	3,407,827	6,756,202	9,316,090
Northern and Western (Old).....	6,548,858	5,514,978	5,335,613	13,581,865	13,657,555	13,619,420
<i>Per Cent Distribution</i>						
New immigration.....	44.5	53.6	54.6	20.0	33.0	40.6
Old immigration.....	55.5	46.4	45.4	80.0	67.0	59.4

birth rate than the countries sending the bulk of the immigrants before 1900. The figures in Table 5 reflect the fact that the second generation of the older groups has remained stationary, while that of the newer immigration is rapidly becoming an important element in the population. This is ascribable in part to the increased age of the earlier migrants and in part to the higher birth rates among the new immigrants. There is some evidence that the immigrants from countries with a high birth rate continue to maintain a high birth rate in this country.

GEOGRAPHICAL DISTRIBUTION OF IMMIGRANTS

The destination of newly arrived aliens is indicated by their declaration regarding the state of their intended future permanent residence. In general, the vast majority of immigrants have settled in the more densely populated and industrial sections of the country. The presence of relatives or friends in these states with a great alien population served as an added attraction to newcomers to settle there. The states which had about three-fourths of the foreign-born population in the United States in both 1920 and 1930 received four-fifths of the total immigration during the past twenty years.

Ten states, all except two of which are located in the northeastern section of the country, averaged nearly 24,000 immigrants per state per year during the past twenty years, while by contrast twenty-five other states, all in the South and the West, averaged only 600 immigrants per state per year; moreover, in this period these twenty-five states together totalled only slightly more immigrants than the corresponding figure for New Jersey alone. The contrast between these two areas is more sharply defined when it is noted that during the past twenty years the ten highest states received twice the net immigration needed to replace the deaths among their foreign-born population and consequently have experienced a substantial gain in this class since 1914, while on the other hand

EFFECT OF IMMIGRATION ON POPULATION GROWTH

the net immigration to the twenty-five lowest states was only about one-third of the deaths among their alien population, with the result that they sustained a heavy net loss in this class of population.

OCCUPATIONAL STATUS OF IMMIGRANTS

There are striking changes in the previous occupations of immigrants between those entering during the period 1911-1914 and those entering during the period 1925-1930. The former reflect conditions before the war and the quotas, and the latter conditions after rigid legal and administrative restrictions had been put into practice. The small proportion of professional people was more than tripled in the later period. This was to be expected, as the law of 1924 placed ministers and professors in a non-quota class. Shutting off the flow of immigration from southern and eastern Europe has also resulted in an increase in the proportion of entrants who are in the skilled class, with a corresponding decrease in the propor-

OCCUPATIONAL STATUS OF IMMIGRANTS ADMITTED

	Number		Per Cent	
	Average 1911-1914	Average 1925-1930	Average 1911-1914	Average 1925-1930
Professional.....	12,948	10,640	1.7	6.1
Skilled.....	152,306	54,260	20.0	30.9
Unskilled.....	567,196	93,964	74.7	53.5
Farmers and farm laborers.....	253,323	29,038	33.4	16.5
Common laborers and servants..	313,873	64,926	41.3	37.0
Commercial.....	14,995	5,445	2.0	3.1
Miscellaneous.....	12,215	11,171	1.6	6.4
Total with occupation.....	759,660	175,480	100.0	100.0
No occupation.....	273,624	118,265	26.5	40.4
Grand Total.....	1,033,284	293,745	—	—

portion of the unskilled. When the unskilled class is further divided into farmers and farm laborers, and common laborers

and servants, it is found that the proportion of the former has decreased by over one-half, in spite of the quota preference given to farmers. Common laborers and servants, however, continued to enter in almost the same relative volume. Of the total immigrants admitted, there has been a decided increase in the proportion with no occupation, which is to be expected considering the larger number of women and children who have entered in recent years.

ILLEGAL ENTRY OF ALIENS

The surreptitious entrance of foreign nationals into the United States by the variety of methods employed to evade legal restrictions has received a degree of publicity seemingly disproportionate to the probable magnitude of this unlawful migration.

Alien smuggling has been a most troublesome phase of the immigration problem ever since the enactment of the first Chinese exclusion law, and for a good many years such operations were largely confined to bringing aliens of that race into the country. With the development of the general immigration law, however, the practice spread to other aliens of the diseased and otherwise inadmissible classes, and, as the law became more complex, the prevention of smuggling and surreptitious entry by other means became correspondingly difficult.

Closely allied to border running is the illegal entry of alien seamen who come to United States ports as members of ships' crews and, taking advantage of shore privileges granted under the law, desert the vessels bringing them and remain in the country. During the past twenty years about 220,000 alien seamen were reported to have deserted their ships, with the peak of 35,000 in 1924 coinciding with the drastic quota law restrictions. During recent years the number has declined rapidly from 9,100 in 1930 to only 664 in 1933 and 972 in

1934, reflecting the diminution of employment opportunities in this country.

The organization in 1925 of a land-border and sea-coast patrol of 450 men (gradually strengthened to 984 in 1932) to supplement the regular immigration inspection forces provided for more adequate protection of the international boundaries than was possible previously; and the deterrent effect exercised by the patrol has been a most important factor in keeping alien smuggling efforts and other illegal activities along the borders within bounds.

The causes for the deportation of aliens to their native countries have steadily increased in number during recent years, and the time within which aliens are subject to such regulations has continued to lengthen. Moreover, successive immigration laws have become more rigorous in their provisions for exclusion and the penalties for violations have become more severe. Thus the threat of imprisonment, fine, and deportation tends to deter surreptitious entry of aliens and frighten away those who are already here illegally. The number of aliens deported has increased steadily since the quota law went into effect, rising from 3,661 in 1923 to 19,865 in 1933. As a result of the depression, activity in the removal of aliens illegally resident in the United States has been greatly stimulated in recent years.

SUMMARY

During the first hundred years of our recorded immigration history, when there was no numerical limitation, 92 per cent of all aliens admitted to this country came from Europe, whereas during the succeeding 10-year period (1922-1931) the quota laws restricted European immigration to only 56 per cent of the total number. Moreover, the European stream has shown wide variations in its national composition. Prior to 1880, seven out of every eight European immigrants came from northern and western nations—Belgium, France, Germany,

the Netherlands, Scandinavia, Switzerland, and the United Kingdom—but during the following forty years the pendulum swung the other way, with 60 per cent coming from other European countries, comprising Austria, the Balkan States, Greece, Hungary, Italy, Poland, Portugal, Russia, Spain and Turkey. Finally, the result of the quota laws effective during the past decade was not only to reduce very materially the proportion of immigrants coming from Europe but also to turn the tide in favor of the old sources again, the northern and western countries accounting for five out of every eight immigrants from Europe between 1922 and 1931.

As a result of immigration influences, the racial character of the United States has undergone radical changes in the past twenty years. Up to 1914 the country was becoming more heterogeneous owing to rapid immigration and the spread of aliens into communities theretofore populated almost wholly by native Americans. Since 1914 the most striking development has been the marked diminution of European immigration, due to various factors; first the war, then statutory laws, and finally the depression. Back of the legal limitations on immigration has been a change in national sentiment regarding America as a refuge for all people and an effort to arrive at a restrictive policy.

Several factors contributed to a reversal of sentiment regarding the open-door policy about 1920, among the most important of which were the reduced need for foreign labor and the shift of European immigration from countries of Northwest Europe to Russia and the countries of Southeast Europe—a shift which naturally tended to create increasingly difficult problems of assimilation.

In volume of growth alone, the change has been far-reaching. The reduction from an average annual immigration of nearly 1,000,000 during the first fourteen years of the Twentieth Century to a corresponding figure of only 290,000 in the following 20-year period does not entirely measure the shrink-

age, for these foreign born had the highest birth rates of any nativity class in the population and by restricting their numbers the natural increase has also been slackened. On the basis of the trends in immigration in addition to those of births and deaths, it is possible to predict that if the present immigration situation continues and the present mortality rates continue, the number and proportion of foreign born in the population will markedly decrease. Later the proportion of children of immigrant parents will decline. These changes will tend to produce a more homogeneous population in which the native element will increasingly predominate.

R. L. TOMBLEN

Notes on Recent Occurrences

DR. JEWETT RECEIVES AWARD OF FARADAY MEDAL

ANNOUNCEMENT was made in London, England, on January 25, that the Council of the Institution of Electrical Engineers had unanimously voted to award the Faraday Medal for 1935 to Dr. Frank B. Jewett, Vice President of the American Telephone and Telegraph Company and President of the Bell Telephone Laboratories.

The practice of awarding the medal, which was instituted in 1922, had as its object the commemoration of the fiftieth anniversary of the first meeting of the Society of Telegraph Engineers, which later became the Institution of Electrical Engineers. Under the terms of the resolution establishing the award, the medal may be awarded not oftener than once a year "either for notable scientific achievement in electrical engineering, or for conspicuous services rendered to the advancement of electrical science, without restriction as regards nationality, country of residence or membership in the Institution."

The medal is of bronze. At the time of its establishment, it was announced that it was desired by the Institution that "there should be no suggestion of any intrinsic value in the medal itself, but rather that it should owe its value, first, to the fact that it was to commemorate an important event in the history of this Institution; secondly, that it was offered for world-wide services without any restrictions; and lastly, that it was hoped, as time proceeded, its importance would be advanced by the illustrious names of its holders."

The medal has been awarded each year since 1922, with the exception of 1933. The recipients of the award have been:

Oliver Heaviside, Sir Charles Parsons, Dr. S. Z. deFerranti, Sir Joseph John Thomson, Col. Rookes Evelyn Bell Compton, Elihu Thomson, Sir J. A. Fleming, Guido Semenza, Lord Rutherford, Charles H. Merz, Sir Oliver Lodge, Sir Frank E. Smith, and Dr. Jewett. Of these, Elihu Thomson and Dr. Jewett are the only representatives of the United States.

MICHAEL PUPIN, INVENTOR OF THE LOADING COIL, IS DEAD

(The following article was written for Bell System employee publications by President Frank B. Jewett of the Bell Telephone Laboratories.—Ed.)

BECAUSE of his prominence for many years in the fields of science and engineering, and particularly in the field of electrical communication, the announcement of the death on March 12 of Dr. Michael I. Pupin of Columbia University is a matter of deep regret to a large number of telephone people.

While never officially connected with the Bell System, Dr. Pupin had for more than thirty-five years played an important part in the development of the Bell System. His invention of loading as a means of greatly extending and improving the transmission characteristics of open wire and cable circuits was a vital factor in the development of a comprehensive nationwide telephone system. The American Telephone and Telegraph Company purchased Dr. Pupin's patents on this invention at the time of their issuance. This outstanding invention raised Dr. Pupin to the front rank of scientific men and brought to him recognition from all parts of the world.

Although the loading invention was unquestionably the principal of Dr. Pupin's contributions to the art of electrical communication, it was not by any means his only contribution. Particularly in the field of high frequency transmission, both by wire and by radio, Dr. Pupin's work added notably to progress.

Throughout the many years of his contact with the scientific work of the Bell System, Dr. Pupin contributed in many ways

which were not and could not be measured in terms of concrete things. The close personal friendships which were established between him and the late General Carty, Mr. Gherardi and Dr. Jewett were valuable in the opportunity which they gave to partake of his wise counsel and advice. Nor was this counsel confined wholly to matters of science and engineering, for Dr. Pupin was a man of great wisdom and force in many matters.

He was endowed with a lovable disposition which impelled him always to extend help where he could. This was particularly noteworthy in his attitude toward young men. It was his boast that his greatest achievements were not the results of his scientific work but were his discovery and training of men who later attained to eminence.

In his death the Bell System has lost an ardent and steadfast supporter of its work and its policies, and many of its members individually have lost a cherished friend.

BELL SYSTEM TO EXHIBIT AT CALIFORNIA EXPOSITION

AT San Diego during the coming summer will be held the California Pacific International Exposition. In that exposition the American Telephone and Telegraph Company will have an exhibit on behalf of the Bell Telephone System. It will be located on a corner of the main plaza and the central avenue through the exposition grounds. It will be in effect an independent building on the street level, with an entrance at the corner, and large arched windows on either side through which the passer-by may get a view of the exhibit area.

The exhibit will center on the concept of the "telephone voice," with three demonstrations. One will be an oscilloscope permitting a visitor to see the wave form of his own telephone voice. Another will allow him to hear over the telephone exactly how his voice sounds to others when he is telephoning them. The third exhibit is a demonstration of inverted

NOTES ON RECENT OCCURRENCES

speech, showing how privacy is introduced into radio telephone conversations and the peculiar and unintelligible sounds which represent a radio telephone message in transit over the ocean.

Like the 1933 Century of Progress exhibit in Chicago, the one at San Diego is under the general direction of Vice President A. W. Page of the American Telephone and Telegraph Company, and Dr. F. B. Jewett, President of Bell Telephone Laboratories. Its design is being carried out in the Laboratories under the direction of John Mills, and its technical features are being arranged by M. B. Long. The operating staff will be recruited from the forces of the Southern California Telephone Company, and the manager of the exhibit during operation will be Paul L. Johnson of that company.

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WIDE BAND TRANSMISSION IN
SHEATHED CONDUCTORS

DUST STORMS AND TELEPHONE
SERVICE

ELECTRICAL COMMUNICATION:
PAST, PRESENT, FUTURE

THE CHANGING YEARS AS SEEN
FROM THE SWITCHBOARD

THE WORLD'S TELEPHONE
STATISTICS, JANUARY 1,
1934

BELL TELEPHONE QUARTERLY

*A Medium of Suggestion
and a Record of Progress*

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Wide Band Transmission in Sheathed Conductors

THE Annual Report of the American Telephone and Telegraph Company for the year 1934 speaks of "A radically new form of transmission cable adaptable for use either overhead or underground on heavy traffic toll or long distance routes." The development referred to and another development covering carrier systems for use in existing cables or cables of similar types may be classed together under the title, "Wide Band Transmission in Sheathed Conductors."

These developments have been well presented in four papers entitled:

"Carrier in Cable"

"Systems for Wide Band Transmission Over Coaxial Lines"

"Wide Band Transmission Over Balanced Circuits"

"The Electromagnetic Theory of Coaxial Transmission Lines and Cylindrical Shields"

The first of these was presented at the summer convention of the American Institute of Electrical Engineers in 1933. The others were presented at a similar convention in January of this year. Other technical papers have covered important features of these developments, notably a paper on "Stabilized Feedback Amplifiers" presented at the 1934 midwinter convention.

The present article has been prepared in response to the suggestion that readers of the *QUARTERLY* may be interested in a brief discussion of certain of the outstanding technical features that these papers have presented.

TECHNICAL FEATURES

These papers all deal primarily with forms of telephone circuits in "cable." Where such cable construction is employed,

the circuits will generally be included in lead sheaths, the diameter of these sheaths being no larger and frequently much smaller than the diameter of full size telephone cables.

For routes carrying many circuits, cable has advantages which are well recognized in the telephone art. It is exactly for such congested routes that these new developments have an important field. They will have, as do other forms of sheathed conductors, the great advantages of an impervious metal wall which shuts out the weather except for its temperature changes and minimizes the effect of outside electrical fields such as those produced by adjacent power circuits. When the cables are placed underground, temperature changes penetrate very slowly and physical hazards are lessened.

It is characteristic of these systems that each wire circuit carries a wide frequency range. This idea is not wholly new to telephone people, since it has been common practice for some years for pairs of open wires to carry frequency ranges to an upper limit of around 30,000 cycles. These new systems are remarkable in that the wide range is applied to sheathed circuits, which have the inherent inefficiency of any circuit in which the wires are close together, and in that the frequency ranges transmitted do not stop at the present limits of open-wire circuits but go boldly up to possibly 60,000 cycles in existing cables and to one or more millions of cycles for circuits in specially built cables.

Such systems would be of little use for telephone purposes were it not for the fact that each wide frequency band can be readily carved into slices of just the right width to carry any desired type of communication. These slices may be 4,000 cycles wide to transmit telephone messages, somewhat wider for program circuits, only 100 or 200 cycles wide for telegraph transmission, and one or more millions of cycles wide if television circuits are required. It is not possible, however, to make very sharp edges to these slices. Because of this a region along the borders of each slice can not be effectively used

for the transmission of the message but must be left to prevent adjacent messages overlapping into each other. For example, each ordinary telephone circuit probably will be given a width of somewhat over 2,800 cycles. The difference between this and the 4,000 cycles taken by each telephone slice represents these separating regions.

This idea of slicing up frequency ranges is also not new to telephone people, since in the open-wire carrier systems now employed the total range up to 30,000 cycles is divided into six one-way carrier telephone circuits, leaving the lower end for an ordinary telephone circuit. The remarkable features of the new developments are the extent to which this slicing has been carried and the methods employed. Let us assume, for example, a one-million cycle band, and further assume that the lower 100,000 cycles is discarded. This still leaves a 900,000-cycle band in which there is room for some 225 slices, each of the width required to carry a one-way telephone circuit.

Since the power losses suffered by currents passing over a wire circuit increase with the frequency, these wide bands in sheathed construction necessarily mean that the high frequencies die out very rapidly as they travel along. To overcome this, it is necessary to place vacuum tube repeaters at frequent intervals. We have come to think of around fifty miles as a normal repeater spacing for cables. For these new systems, repeaters will be spaced perhaps at twenty mile intervals or less for the lower frequency ranges and ten mile separations or even shorter for those transmitting very high frequencies. This close spacing of repeaters is made practicable by recent developments in the form of amplifiers, as discussed later. Since each repeater handles the whole range of frequencies passing over the circuit, the cost of the repeater may be divided among the many separate communication channels which it carries.

Separate circuits in sheathed cable must necessarily be close neighbors. Crosstalk between them has long been an out-

standing technical problem. In general, not more than about a millionth of the power in a telephone circuit may be permitted to pass over into an adjacent circuit. As the frequencies are increased in ordinary types of cables, the problems become more difficult. For the frequencies involved in these systems, it is necessary in some way to take advantage of the fact that if circuits are separated from each other by metal shields their effect on each other is very much reduced.

The first difficulty which appears in using high frequencies is where groups of circuits transmitting messages in one direction are adjacent to groups of circuits transmitting messages in the opposite direction. This is due to the fact that large energies may be going out, for example, from a repeater station, on circuits of one of the groups, while the other group is receiving very small energies from some distant repeater station. The first use of shielding, then, is the simple one of placing the groups of circuits transmitting in one direction in a cable separate from that carrying the groups of circuits transmitting in the opposite direction. Where transmission in the two directions is thus kept in separate cables, it is possible to transmit up to, say, 60,000 cycles over a considerable part of the conductors in existing cables by means which have been developed for improving the balance of the different circuits to each other. This consists of installing, in each repeater section, sets of little coils and condensers between a large number of combinations of wires in each cable. We may see considerable use of wide band systems transmitting up to about 60,000 cycles along the existing cable routes where separate cables are available for transmission in each direction.

If we keep to this same idea of having the two directions of transmission in separate cables, it is possible to build new cables of so greatly improved balance that very high frequencies can be transmitted over them without mutual interference. For such new construction, it is also possible to put

the two directions of transmission in one cable if we divide it by shields into two parts.

A more flexible arrangement is made by wrapping a metallic shield around each individual pair of wires. This permits properly constructed pairs to transmit frequencies of a million cycles or more and yet be bundled together without considering in which direction each is transmitting. Another form of construction consists of a central wire surrounded by, and insulated from, a flexible outer tube of metal. This has become known as the "coaxial circuit." It may be thought of as starting with a shielded pair of wires with one of the wires removed and the shield itself used as the return conductor. It is a nice question as to the relative advantages of the shielded pair and the coaxial circuit. At voice frequencies and for some distance above, the pair is preferable because the shielding effect of the outer conductor is not large at low frequencies and the symmetry and balance of the pairs are needed to prevent mutual interference between adjacent circuits. For wide bands extending to very high frequencies, the lower part of the frequency range may be left idle with little loss. For the high frequencies, the shielding effect is so perfect that the balance of the pairs is not important. It is proposed to make a trial installation of a circuit of the coaxial type.

There are many interesting developments connected with each of the new features of these systems. Of particular importance is the form of amplifier used. In this, some of the energy from the output is carried through special circuits and put back into the input in such a way as to lower the amplification but obtain remarkable stability and freedom from distortion of the amplified currents. The amplification used in each repeater is over one thousand times the amplification which has been used in the carrier system on open-wire lines. The powers in the transmitted messages are allowed to go down to the point where the noise due to the motion caused by heat of the molecules of the conductors becomes the limiting considera-

tion. Convenient modulators and demodulators are made of solid material rather than vacuum tubes. Electrical filters make use of mechanical elements. Automatic regulators hold the transmission efficiencies of the circuits closely constant, independent of temperature variations or other changes.

It is not necessary, however, to go deeply into these interesting features to understand the broad principles involved. Essentially we have: (*a*) closely spaced circuits surrounded by sheaths; (*b*) shielding playing a very important part in preventing interference into and crosstalk between the circuits—this possibly carried to the point of having each circuit consist of a single wire entirely surrounded by a shield, the shield acting as the second wire of the circuit; (*c*) each circuit containing many repeaters but transmitting through them a wide band of frequencies; and (*d*) arrangements at the terminals to carve such a wide band into slices of just the right size and to place the corresponding types of communication into them.

VIEWPOINTS

One type of person likes to think of any new development as a fulfillment of the past and delves deeply into the history of the art to find the beginnings of the ideas which have created it. Another type appears more interested in the newness of the methods employed and takes delight in noting how completely the development departs from past practices. It so happens that these present developments can well satisfy an observer with either of these viewpoints.

For the first, we may note that in the use of a high-frequency range, with the messages separated by selective devices from each other, these systems are closely related not only to our carrier systems over wire but to radio. We may note, further, that before radiotelephone methods were known, crude forms of carrier telephone systems over wires were invented and experimented with to some extent. For telegraph, we can go back to Dr. Bell himself, who, when he invented the telephone,

was working on a telegraph system in which a number of messages could be transmitted simultaneously over a wire circuit using different frequencies.

For the second of these types of mind, there are many features of the systems, each of which is a striking departure from the past. We are already accustomed to tremendous amplification in ordinary cable circuits; but consider what is involved in transmitting the wide bands through sheathed conductors! If a commercial call is now put up over cable facilities, say from Bangor, Maine to Fort Worth, Texas, the total power amplification involved is 10^{120} (equal to the figure 1 followed by 120 ciphers) under average conditions, and more under highest temperature conditions. This is the ratio of the energy actually received over the circuit to that which would be received without amplifiers, supposing, of course, that the minute amount was not lost in interference. This ratio has been picturesquely stated as about that between the volume of the electron and the volume of the universe as suggested in Jeans' book on "The Universe Around Us." If we consider, however, the transmission of a million cycles through a coaxial conductor of about one-third inch in diameter over a 3,000-mile cross-country circuit, we have a power loss of about 10^{1800} , which, it will be noted, is the present tremendous amplification of the Maine to Texas call multiplied by a ratio represented by the figure 1 followed by 1,680 ciphers. Moreover, this tremendous amplification must be maintained by automatic regulation so closely to that of the total loss in the cable, that the resultant difference will not vary more than that which would be caused by a few miles of 19-gauge cable in an ordinary circuit.

A frequency range approximately a million cycles wide contains all the ordinary broadcasting channels in this country. One of these proposed million-cycle wide circuits will then transmit a frequency range as wide as that used in such broadcasting. This range, furthermore, it is proposed to divide into

over 200 telephone channels. Incidentally, any one of the telephone channels can itself be carved into a dozen telegraph channels.

The comparison between a coaxial circuit of perhaps one-third inch diameter carrying a million cycles and the methods used in radio transmission for a similar frequency range is very interesting. In the radio case the waves are of comparatively great power spread out over a tremendous area. In the sheathed conductor case it is as though a little bit of space is taken in the form of a long tube of small diameter extending for long distances but this space so carefully shut off from all its surroundings and so carefully adjusted and controlled that hundreds of independent messages of low power can be simultaneously transmitted through the narrow region.

Since the early days of telephony, the use of ground return circuits with their inherent unbalance has been confined to out-lying country regions. Balance has become one of the primary considerations of the telephone system, particularly for toll purposes. These wide band systems involve two outstanding developments as regards balance. First, in connection with the use of wide bands in existing cable, balance has been necessarily carried to a refinement which is far beyond anything ever before attempted. In the very high ranges, moreover, as already noted, it is quite possible that balance will be entirely abandoned, complete dependence being placed on the shielding effect of the shell forming a part of the coaxial circuit; thus the art returns for such systems to an unbalanced circuit.

Not the least of the departures from past practice concerns the use of telephone repeaters. On the present cable toll routes, repeater stations are separated at intervals of around fifty miles. These stations may each contain a considerable number of repeaters. They are equipped with testing arrangements and with highly reliable power supply. For most of the time they are attended by maintenance people. With these new systems, stations of somewhat similar form and sep-

aration will be required, although the number of repeaters may be reduced because of the large number of channels carried by each repeater. In addition, these new systems will require repeater stations intermediate between these principal repeater stations, the number depending on how wide a frequency range is being transmitted over the circuits. As already noted, the spacing between repeaters on very wide band systems may be as short as ten miles or less. All of these repeaters could not be handled in the same manner if the systems are to remain economical. To meet this changed situation, repeaters are being developed to be self-contained units of such size that a small number may be placed in manholes, hung on poles or housed in other convenient ways. They must be of such form and so housed that they can operate for considerable periods without attendance. To insure further against failure of these unattended repeaters, the current to operate them may pass over the wires in the cables themselves.

In the "filters," which are the selective devices which play a highly important part in carving up the frequency ranges, there is an interesting departure from past practice in the use of mechanical vibrating elements in place of electrical resonances. The communication engineer has generally felt that electrical circuits had possibilities of flexibility and control far beyond anything that mechanical devices could afford. We have in these filters, however, a deliberate use of mechanical vibrating elements because such elements vibrate with less energy loss than any electrical circuit which can be devised at comparable cost.

USE OF WIDE BAND SYSTEMS

Although our Laboratories are well advanced in the forming of these new systems, considerable further development work is required for commercial application. Furthermore, the time of the introduction will depend upon a great many factors, in-

cluding the demand for additional large groups of communication facilities. Their practical introduction is, therefore, not immediately contemplated and in any event will necessarily be a very gradual process.

The plant of the Bell System is so extensive and includes so many different conditions that the picture we get as to the use of these developments depends a great deal on where we look. It is perfectly evident that if we confine our attention to the important routes between the large cities in the highly industrialized sections of the country, there are large possibilities of caring for further growth, first, by application of these developments in the lower frequency ranges to existing cables, and later by the still wider frequency range systems as further growth takes place or replacements of plant become necessary. If we take the toll plant as a whole, we are met by the fact that in any country-wide system giving universal service, there are necessarily long stretches and a large total line mileage where the demands for facilities are not heavy. For such situations, no forms of sheathed conductors can now compete economically with open-wire circuits. The use of the systems will also be considerably influenced by the results of the effort being made to make them available for comparatively short lengths.

A factor in attempting to assess the future use of these developments is television. The development of television transmitting and receiving equipment has made large advances in recent years. Along with this, however, has come an increasing realization that only the tremendous frequency widths of a million cycles or more will give worthwhile results. The transmission of these very broad bands forms a highly important part of the over-all technical problems of television. The transmission problems start with the production of the currents at the point where the interesting event is happening, and continue to the points where the currents enter the receiving sets. This transmission may involve radio broadcasting stations and the sets receiving from them. It may also involve circuits

extending from the pick-up point to these broadcasting stations or to other distributing centers. Whatever may be the final field of television, these wide band developments represent an outstanding contribution to the solution of the transmission problems involved.

O. B. BLACKWELL

Dust Storms and Telephone Service

Editor's Note:

The following report to the Chief Engineer of the Southwestern Bell Telephone Company by the Company's General Building and Equipment Engineer refers to a sectional situation but is printed here because of its general interest to all readers of the BELL TELEPHONE QUARTERLY who are concerned with the maintenance of telephone service under unusual conditions.

THE dust storms which have raged intermittently through the western Great Plains area for the past year and a half have been called to the attention of nearly everyone living east of the Rockies, either through the newspapers or by personal observation. The heavy rains of May have turned much of the dust bowl into a sea of mud, and the memory of the dust storms, like most catastrophes, is rapidly fading into the past, except, perhaps, to those most intimately concerned. Nevertheless, it seems appropriate and of probable interest at this time to review this great phenomenon, its causes and effects, and especially its reactions upon the telephone service in the areas immediately affected and those contiguous thereto.

The general area within which these storms originated is indicated in Figure 1. This coincides, in general, with what is quite commonly known as the dry farming regions of West Texas, Oklahoma, Kansas, Nebraska and the Dakotas. It is interesting to note that in this area there is raised on an average about one-third of the total wheat crop of the United States. The territory most affected by the storms includes this area of origin and also as far east as the Mississippi River. While the effects were observed still further east, they were more in the nature of a transient phenomenon. Dust from these storms has been reported as far distant as New Hamp-

DUST STORMS AND TELEPHONE SERVICE

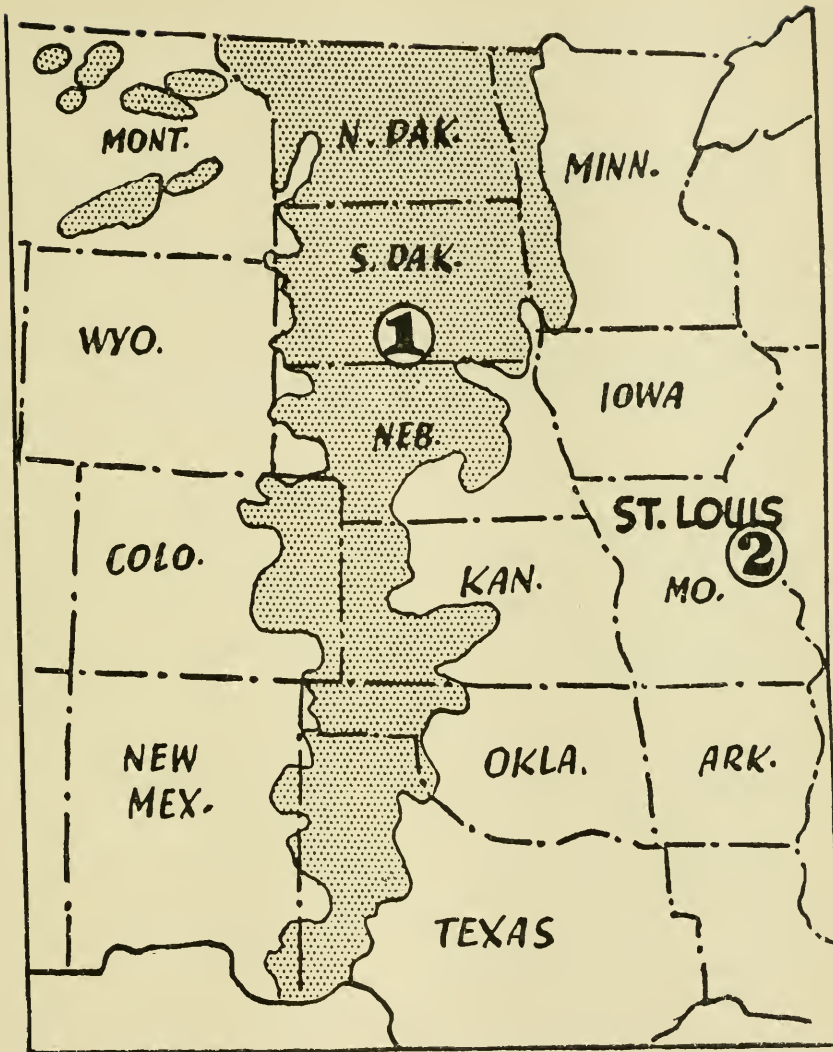


FIG. 1. THAT DUST EROSION IS NOT AN ISOLATED PROBLEM IS INDICATED BY THIS MAP. EROSION WAS MOST SEVERE IN THE DRY-FARMING BELT (1) EAST OF THE ROCKY MOUNTAINS FROM WESTERN TEXAS TO THE CANADIAN BORDER. WITH A PREVAILING WESTERLY WIND DURING MOST OF THE SPRING, THE DUST CLOUDS WERE CARRIED OVER A VAST AREA IN THE MISSISSIPPI VALLEY, OF WHICH ST. LOUIS (2) IS THE CENTER.

shire and points in the Gulf of Mexico and even out over the Atlantic Ocean.

A DESCRIPTION OF THE STORMS

Throughout the areas most seriously affected, a bright clear day was rare and the air most of the time was filled with fine dust particles. The more severe storms occurred with almost the suddenness, although not the accompanying violence, of a tornado. Out of a comparatively clear sky a black cloud would suddenly appear, and within ten or fifteen minutes an entire town would be enveloped to the extent that visibility was reduced practically to zero, and breathing became extremely difficult.

These severe storms frequently continued for six or seven hours, during which business practically ceased and people remained indoors. A number of instances are reported wherein the residents of even small towns became lost and were unable to find their way home until the storm had subsided. At the height of one of the storms, a passenger train failed to make a scheduled stop because the engineer was unable to see the town as he passed through it. As a rule the railroads, bus companies, and state highway officials ordered all traffic stopped during the worst periods, in the interest of safety.

At the height of a severe storm, the darkness was so great that it was literally much darker than the darkest night. The darkness was almost impervious to the headlights of an automobile or even of a locomotive, due to the presence of such great quantities of dust in the air. Some appreciation of the density of these dust clouds may be obtained from the accompanying photographs. Figure 2 shows the approach of the dust clouds. Figure 3 was taken on the main street in Garden City, Kansas at 5:15 on the afternoon of April 14, 1935, and Figure 4 from the same point fifteen minutes later.

The densest dust clouds were, of course, formed by the higher velocity winds, the highest recorded being in the order of 38 to

40 miles per hour. These high winds carried such great amounts of dust that drifts were deposited against fences and across highways and in some cases almost covered farm buildings. Some idea of the drift deposits may be obtained from Figure 5, which shows the piling up of dust along a railroad right-of-way. The pole line in the background is a section of the Kansas City-Denver line between Ingalls and Garden City, Kansas. The rather startling effects of the drifting dust are also illustrated in Figure 6, which shows a tractor practically buried.

In addition to the drifts, great quantities of dust were gradually deposited after the full force of the wind had subsided. Figure 7 shows the dust being removed from the Telephone Building lawn at Dodge City, Kansas, after one of the worst storms of this year. In Figure 8 the dust removed from the Telephone Building lawn at Garden City has been collected into one pile containing approximately two tons of deposit. This was taken from the grass plot, which measures 15' x 30'. At the State Experimental Farm near Garden City, the dust removed from the lawn was weighed and estimates made indicated a deposit of 350 tons per acre.

The effect of the storms was, of course, most severe in the immediate dust bowl area, but extended as far east as St. Louis with severity sufficient to diminish the sunlight and cause decided discomfort to inhabitants. Cities west of St. Louis and, of course, nearer the dust bowl, such as Kansas City and Oklahoma City, were affected to a considerably greater extent than was St. Louis. A peculiar phenomenon attending these storms was the steel-blue appearance of the moon and even of the sun at midday because of the dust in the atmosphere. At points as far removed from the dust origins as St. Louis, there was the depressing reaction due to the lack of sunshine and the feeling that valuable property was being destroyed in neighboring states. Housewives were more materially affected, as shown by their endeavors to keep their homes free from dust.

The dust clouds were composed of the more finely divided particles which make up the top soil of the high plains regions. The principal constituents are quartz and the silicates of aluminium, sodium, potassium and calcium, with some organic matter. The particle sizes vary between rather wide limits, but the majority have been found to be close to four ten thousandths (.0004) of an inch in diameter. This dust is so fine and clings so closely that it is almost impossible to remove it by ordinary sweeping or dusting methods.

CAUSES OF THE DUST STORMS

Now, as to the causes of the dust storms. The impression that these storms are new to the high plains regions should be dispelled. While the storms of the past year and a half have been of unusual severity, dust storms have been a rather common occurrence for many years. As a matter of fact, they were recorded in Kansas as early as 1830, when a Rev. Isaac McCoy reported encountering dust storms during an expedition leaving Ft. Leavenworth, Kansas, in September of that year. His description is similar to that of present day storms.

The reason for the unusual severity of the recent storms is probably a combination of several factors. An enormous acreage of pasture or grazing land had been broken and placed in cultivation during and immediately following the World War, due to the high price of wheat prevailing at the time. The level nature of the country and the low cost of the land were favorable to the use of heavy-type planting and harvesting machinery, and wheat raising was undertaken on a very large scale. "Dry farming" was extensively practiced and one successful season followed another, with the natural result that more and more acreage was placed under cultivation, and the beginning of the present decade found the high plains supporting a greater population than ever before.

Beginning with the year 1930, however, there have been five successive years wherein the rainfall was either greatly deficient

or ill timed for the support of vegetation. In the western Kansas section in these five years the precipitation each year has been below the average and each year lower than the preceding one. As a natural consequence, vast areas were practically denuded of vegetation and left without protection from the erosive effect of the winds which blow almost continually in the high plains regions.

In its natural state, this prairie country is covered by a thin but tough stand of a short grass known locally as buffalo grass. This is a very effective covering, preventing wind erosion of the soil. During the drouth of the past five years all vegetation, including this buffalo grass, suffered a great deal and, in addition, the grass which remained in the area not under cultivation was grazed more closely than usual in an effort to prevent the starvation of cattle. This further denuded the soil and exposed practically the entire area to wind erosion.

The impression prevails among some that irreparable damage has been done to the fertile soil of this great wheat raising section of the United States. It is the opinion of leading agronomists that while no doubt there has been some damage done to top soil, particularly in the areas affected by the worst dust storms, on the whole very little permanent damage has resulted. In the immediate dust bowl area it amounted to some extent to a transfer of the soil from one section to another and then a re-deposit back, due to shifting winds. In the area outside of the dust bowl region the deposit of fertile dust has, no doubt, enhanced the value and fertility of the soil. It is estimated that in Kansas, out of eight million acres subject to erosion and blowing, only about 350,000 acres have been seriously damaged. Of course, a serious effect is the loss of the wheat crop for 1935, but some authorities feel that the lack of moisture during the winter had in any event precluded a paying crop for this year. The drifted soil, too, presents a problem which will entail considerable expense before these drifts

are removed and spread evenly over the land and the lighter deposit mixed with the heavier soils.

While there have always been dust storms in this region, those best informed feel that the destructive storms of the past few years can be avoided by concerted effort to restore vegetation and by modifying farming methods to some extent. It is probable that a considerable acreage should be returned to its native state and used for grazing purposes. The buffalo grass (*Bouchloë Dactyloides*) would be ideal for this purpose if it did not present certain difficulties. It is an extremely short grass, the seed matures very rapidly, and immediately when ripe the entire seed head falls to the ground. As yet no way has been developed for harvesting this seed, but at the Kansas State College consideration is being given to the design of a suction type of machine for harvesting it. In addition, experimentation is under way by State and Federal agencies with European and Asiatic grasses adapted to similar dry regions.

For the areas which are under cultivation, a method called "deep listing" is advocated to prevent dust blowing. A lister, or "middle buster," is an implement similar to a plow, which cuts a deep furrow and deposits the upturned soil on both sides, leaving ridges of large lumps of the harder earth. These resist erosion better than a smooth surface and the ridges also serve as small windbreaks. It is understood that the State and Federal authorities advocate a series of five or six listed furrows every twenty rods and feel that the miniature windbreaks thus provided will prevent serious erosion and any great amount of soil being carried away by the wind; and that the Federal Government plans a belt of trees approximately one hundred miles wide extending from the Canadian border southward into the Texas panhandle. This tree belt is expected to serve both as a windbreak and as a means for conserving such moisture as falls in this area and it is hoped will definitely limit the area of erosion. The difficulties of raising trees in this dry region are obvious and a considerable period will, of course, elapse before



FIG. 2. AN APPROACHING DUST STORM.



FIG. 3. ABOVE: THE MAIN STREET IN GARDEN CITY, KANS., AT 5:15 P.M. ON APRIL 14, 1935.

FIG. 4. BELOW: THE MAIN STREET IN GARDEN CITY, KANS., FROM THE SAME POINT, FIFTEEN MINUTES LATER.





FIG. 5. LEFT: A DUST BANK
ALONG THE SANTA FE RIGHT-
OF-WAY IN THE MIDDLE WEST.



FIG. 6. BELOW: A TRACTOR
ALMOST COMPLETELY BURIED
BY DRIFTING DUST.



FIG. 7. REMOVING DUST FROM THE LAWN OF THE TELEPHONE BUILDING AT DODGE CITY, KANS., AFTER ONE OF THE WORST DUST STORMS OF THE YEAR.

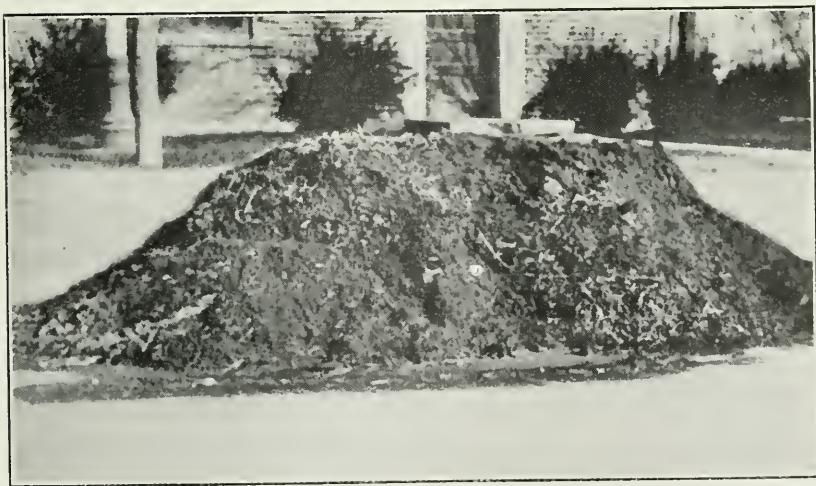


FIG. 8. REMOVED FROM A LAWN ABOUT 15 X 30 FEET, AT THE GARDEN CITY, KANS., TELEPHONE BUILDING, THIS ACCUMULATION OF DUST WEIGHS ABOUT TWO TONS.

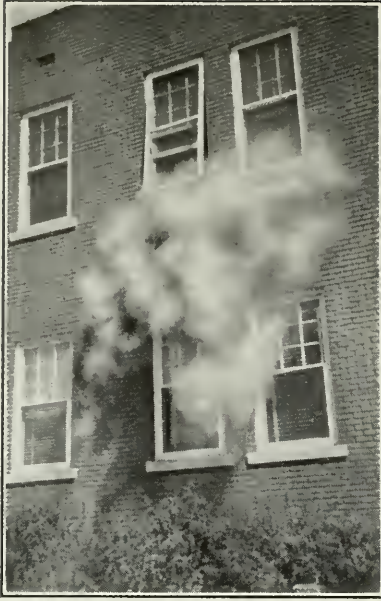


FIG. 9. REMOVING DUST WHICH HAD ACCUMULATED BETWEEN SCREEN AND WINDOW OF THE DODGE CITY, KANS., TELEPHONE BUILDING.



FIG. 10. TELEPHONE LINEMAN EQUIPPED WITH RESPIRATOR, FOR USE WHEN ENGAGED ON NECESSARY OUTSIDE WORK DURING SEVERE DUST STORMS.

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it is known whether this project, if undertaken, will prove of any material value.

EFFECT ON TELEPHONE SERVICE

Telephone switchboard equipment in the areas most affected by the dust storms is of the manual type. The nearest offices having step-by-step dial equipment are at Wichita, Kansas; Oklahoma City, Oklahoma; and Amarillo, Abilene, and Wichita Falls, Texas. Amarillo is actually in the dust bowl and the other towns are outside and some as far as 200 miles distant.

In none of these offices has there been any unusual increase in trouble which might be attributed to the presence of dust. No doubt this is due to the unusual precautions which were taken and to the fact that the equipment was in first class working condition as regards cleanliness before the storms. During the storms, the windows and doors were kept tightly closed and the windows sealed either by means of a plastic caulking compound or by the use of a masking tape such as is used by painters and decorators. The advisability of sealing may be more apparent from Figure 9, which shows a cloud due to the removal of accumulated dust between the screen and window on the second floor of the Dodge City building.

In addition, the unit ventilating apparatus which is available in the dial offices was operated on a recirculating basis, thus repeatedly filtering the dust out of the air in the room. Working conditions in these dial offices were very good even during the worst of the storms. In the offices not equipped with unit type ventilators, switchboards and apparatus as well as floors and window sills were cleaned almost constantly in an effort to prevent accumulations of dust. In the office at Dodge City during one of the most severe storms, the outside working forces were called in to help and the entire switchboard and other equipment were cleaned and the floors mopped seven times in one day. Since some trouble was experienced with dirty relay contacts, the contacts were cleaned and certain of

the relay covers sealed with friction tape to prevent recurrence of the dust trouble.

At one of the connecting company exchanges, the Southwestern Company has a "D" type carrier system which repeatedly developed dirty contact trouble. In order to eliminate this difficulty the carrier equipment was completely enclosed in a box made of wall board which prevented a recurrence of the trouble. As might be expected, there has been some slight increase in central office switchboard troubles and also some at private branch exchange switchboards. These were minimized by frequent routine testing and cleaning, and in some cases even vacuum cleaning after storms was resorted to. By these means much potential trouble was prevented and no serious complaints were received from subscribers.

The very slight increase in station troubles including dials was surprising. In general, the outside plant suffered very little and the only trouble experienced was due to dust collecting in cable terminals, particularly the 14 type. Later, when rains came, some leakage troubles developed due to the combination of dust and moisture. A thorough cleaning eliminated this difficulty.

The most serious handicap to sustained good service was caused by static discharge from rural and toll lines. It appears that, with the extremely dry conditions prevailing, the fine particles of dust and sand in their passage through the air accumulated an electrical charge which upon contact was transmitted to the open wire lines. The effect of these charges was a severe popping noise similar to that experienced at times on the radio and this was frequently severe enough to make conversation difficult or even impossible. Also at times the discharges caused slight shocks to the operators at the switchboards. These shocks occurred chiefly on the rural positions when the operator picked up the calling cord in completing calls from metallic rural lines.

There is not available an exact measure of the severity of

the static discharges, although there are stories to the effect that barbed wire fences, radio antennae and similar wires were luminous at times. Relief from the static discharges which caused interruptions to toll and rural service was temporarily obtained by grounding the circuits through suitable high impedances. In the case of the rural lines, this was done by bridging the circuit with 2500-ohm ringer having the center point grounded. For toll lines, relief was obtained by grounding the phantom circuits, if not equipped for telegraph service, or by grounding the telegraph legs if the circuits were so equipped. These temporary expedients proved quite satisfactory.

Another effect of the static was to charge objects such as automobiles, with the result that a large number of people trailed chains or wires from their cars either to prevent accidental shock from a discharge or to eliminate a fancied danger from explosion of the gasoline tanks. This was a common practice throughout the area, although it was not employed on any of the cars in the Bell fleet.

In common with experience in catastrophes of all sorts, traffic loads increased remarkably during most of the storm periods. From April 10 to 14, when the most severe of the storms occurred in western Kansas, the local traffic loads increased to twice the normal amount and the long distance traffic was from 50 per cent to 75 per cent higher than normal. Except when the toll circuits were seriously affected by static disturbances, ample facilities, both local and toll, were available and it was possible to maintain a uniformly good service. In spite of all precautions, the air in the operating rooms at times was so filled with dust that breathing was difficult and it was necessary to give the operators frequent relief for the purpose of clearing their throats of dust and relieving the strain due to talking under such unfavorable conditions.

The daily papers and the news reels may have created the impression that the dust has caused a great deal of illness and

a considerable increase in the death rate due to pneumonia and other respiratory troubles. While there may have been some increase in illnesses of this type and some increase in the death rate, the records of the Telephone Company's Benefit and Medical Department show no increase in illness attributable to the dust. The Plant forces took the precaution of wearing respirators when engaged in necessary outside work during severe storms and Figure 10 shows a lineman so equipped.

While the Telephone Company's attendance and illness records show no increase, it is possible that the dust aggravated some other conditions which led to the reports of serious illness and death. Reports from the Commissioner of Health of the State of Oklahoma state that a careful examination of the people in the counties most affected disclosed only an irritation of the throat and bronchial tubes. However, the reports further state that it is possible at a later date silicosis may develop as a result of dust irritation. It is expected that there should be an increase in difficulties due to nose and throat irritation even though people in these areas protected themselves as well as possible by covering their noses and mouths with handkerchiefs, towels and bandages of all sorts. School teachers were kept busy performing this service for school children before sending them home and it was reported that in some households one member of the family stayed awake during the night keeping the noses and mouths of the other members covered while they slept.

In conclusion it can be said that while the conditions during the dust storms were extremely severe, yet the records and statistics show little, if any, reaction on the quality of the service. That this is so is due largely to the excellent condition of the telephone plant, to the high quality of maintenance, and especially to the fine spirit of coöperation shown by all of the operating forces.

G. J. VAN DE STEEG

Acknowledgment is made to the Conard Studio, Garden City, Kan., for the use of photographs, and to the St. Louis *Star-Times* for the use of the map showing the area affected by the dust storms.

Electrical Communication: Past, Present, Future

AN ADDRESS BEFORE THE NATIONAL ACADEMY OF SCIENCES IN
WASHINGTON, D. C., ON APRIL 22, 1935 *

FROM time to time during the past twenty years there have been presented at the meetings of the National Academy of Sciences demonstrations of outstanding scientific and engineering achievements in the field of electrical communication. These papers and demonstrations have been portrayals of the striking advances that have been made. They have covered such things as loud speaking telephones and public address systems when they were looked upon as new achievements; various aspects of wire and radio transmission; television; and the transmission and reproduction of orchestral music in perfect auditory perspective.

None of them, nor all of them together, nor all of similar discrete presentations of scientific and engineering progress, can portray properly the philosophy, science and art of electrical communication. In a way, such presentations tend to give a false understanding of what electrical communication really is and of the place it occupies in the social life of the world. Things of this kind, although extremely important, are merely spectacular eminences in the main topography. Viewed alone, they may satisfy our curiosity and provide us transient pleasure and excitement. Viewed against an understanding of the philosophy which underlies the development of electrical communication, they can do all of this and at the same time give us

* More recent statistics are used in this article than were available when it was delivered as an address in Washington, and some of the material has been slightly rearranged for publication.

a real understanding of the level to which the main topography may be raised.

If you here tonight have come in anticipation of witnessing something similar to the transmitted concert which was given in Constitution Hall a couple of years ago, you are destined to a distinct disappointment. It would be easy to produce something of the kind, but what I have chosen to do is to present the other and more important side of the picture as I see it. Probably it may appeal to you as a drab affair, but I hope that it will serve to tie together some of the presentations of the past and likewise to serve as a fiduciary plane for such presentations and demonstrations of electrical communication advances as may be given in the years ahead.

TWO ANNIVERSARIES OF HISTORIC IMPORTANCE

Three months ago there passed, with hardly a notice even among communication people, the twentieth anniversary of the day on which transcontinental telephony was established for the first time. In New York on that day two decades ago, Alexander Graham Bell, his hair and beard whitened with the passing years but using the same instrument into which in Boston thirty-nine years earlier he had spoken the now historic words "Mr. Watson, come here, I want you," again spoke to his friend. Once again he and his friend, the instrument which was the child of his brain, and his historic words, phrased in the somewhat courtly fashion of the time, were inscribing indelibly a page in the book of human history.

This time, however, it was a page consciously prepared for history's book. The actors, the instrument, the very words had been lifted from their shrine and brought forward to float once more for a moment on that stream which never turns backward except when man plays with pageantry, sentiment and love. On this occasion it was a bit of pageantry, something of sentiment and much of love which inspired the act. Nor did the scene from an older era appear to us who were

spectators as inappropriate or out of keeping, even when interpolated in a very modern play. Even the stately language, so foreign to our daily usage, in which the young assistant was addressed, seemed eminently fitting for these participants on such an occasion—anything else would have made the play a burlesque.

One thing only had to be different from the original—the finale. Not again could Mr. Watson play his part by responding to the summons in person, for this time he was three thousand miles away in San Francisco. But he obeyed the command in spirit and in word, and Mr. Bell and all of us who were present heard the reply and knew that another great dream had come true.

A few weeks hence, before most of us are beginning to enjoy our summer vacations, another twentieth anniversary in electrical communication will occur. Probably it too will pass by essentially unnoticed, despite the fact that the event which it will signalize marked not only a monument in the course of electrical communication but likewise the beginning of one of the most astounding eras in the whole history of science. It is an era in which we still live and in which there is as yet little evidence of diminution of the new forces of science which the events of twenty years ago in the field of communication brought into being.

In the spring of 1915, after years of painstaking foundation research climaxed by hectic months of final preparation under conditions where normal difficulties were enhanced a thousand fold by the growing agonies of a World War, human speech was projected across the Atlantic for the first time. Washington spoke to Paris and to Panama and Honolulu and there were no longer any frontiers to telephony, though ten years were still to elapse before commercial service was possible.

Even though we sophisticates of 1935 may take the happenings of 1915 as matters of course, the two developments in communication just mentioned were matters of first importance

at the time. For days and weeks they superseded or paralleled the reports of battles in Europe and for months they filled the magazines with discussions, learned and otherwise, of their future effect on human affairs. In the scientific world the efficacy and power of the physical tools which had made possible transcontinental and transoceanic telephony were at once apparent and journeys began into the fields of improved sound recording, radio broadcasting, talking motion pictures, picture transmission and television, not to mention a thousand and one minor fields of electrical communication and other fields far removed from it.

Quite aside from any influence in collateral fields, the purely communication achievements of 1915 set that year apart as one of the few truly noteworthy years in the annals of telegraphy and telephony. In telephony it is second only to the year of Bell's invention of the telephone itself. It is the year in which man, through science and engineering, gave final answer to the challenge with which from the beginning of time Nature had confronted him. Before 1915, Nature could say to man, "There are limits of distance beyond which you cannot go in free, intimate personal converse with your fellow men; you must work out your destiny within this limitation." After 1915, man could say to Nature, "There are no limits of distance or physical circumstance which you can longer impose on me as regards my need or desire to speak face to face with any man anywhere; from now on I propose to work out my destiny free from this shackle of the past."

So much for a bit of history as a prologue to and justification for an address in 1935 on Electrical Communication. Despite the three equal divisions of the subtitle, I promise to tread lightly in the realms of the past—only enough to elucidate the present and the future. What I should like to do is to give you a thumbnail picture of electrical communication as we have it today and something of the view I have of it in the future. I

do not intend to be technical, for that would interest only physicists, chemists and engineers—possibly not even them.

THE COMMON BASES OF ELECTRICAL COMMUNICATION

What I hope to do, after giving you a very brief outline of the scientific and technical basis of electrical communication, is to picture for you something of the art which has developed during the past sixty years and something of the philosophy which has guided that development. If possible, I should like to fit the separate fragments of the mosaic together so that you will see them for what they really are, namely, integral parts of a single common whole. Such visualization is necessary for a complete understanding. It makes no difference whether your approach is from the realm of science and engineering, from that of commerce, industry or social reactions, or from that of political government seeking to adjust a new art to an old but changing way of living. Unless you can see the picture of electrical communication in full outline, any effort directed merely at a part, whether technical or otherwise, is more likely than not to be abortive in its permanent results.

Partly because of the somewhat fortuitous way in which the several fields of electrical communication have developed, partly because of the vested interests involved and which think themselves in conflict, and partly because of a deep-seated though erroneous set of classifications, it is not easy to visualize this complete picture. Without it we are prone to think and, what is worse, to act in terms of telegraphy, telephony, radio broadcasting, telephotography, or television, as though they were things apart. Possibly our worst sins in this direction are to be found in the fields of business and governmental supervision and control, but science, engineering and social usage are not exempt. To some extent these wholly artificial and misleading classifications have been and are consciously perpetuated by those whose special interests will be served thereby.

For the rest, however, the difficulty is a failure to realize vividly that, one and all, they are merely variant parts of a common applied science. One and all, they depend for their functioning and utility on the transmission to a distance of some form of electrical energy whose proper manipulation makes possible substantially instantaneous transfer of intelligence. Mere transmission of electrical energy in any form does not provide electrical communication. It is the way we manipulate the electrical energy at the transmitting station which gives us our ability to communicate intelligence. Further, whenever and wherever we can transmit electrical energy to a distant point for one form of communication, we can, in general, use that same energy for all other forms of intelligence transmission. Sometimes, to be sure, one form of transmission is better than others for a particular service, but this is usually for reasons of greater reliability, economy, privacy or freedom from inductive interference. Generally, for point to point transmission wire circuits are best, especially on heavy traffic routes, while radio is especially adapted to broadcast transmissions.

In all forms of wire transmission, the electrical energy is always some sort of electric current which is guided by the wire from the sending to the receiving station. The way we manipulate or "modulate" this current at the sending station determines whether we are concerned with telephony, telegraphy, telephotography or television. To make the modulated current humanly intelligible at the receiving station, we must "demodulate" it in some fashion which will reproduce the same physical results as those which existed at the sending station.

In all forms of radio transmission, the electrical energy which is to carry the message is radiated into space at the sending station and is "detected" or picked up at the receiving station. It is made serviceable for intelligence transmission, however, by "modulation" and "demodulation" operations

exactly similar to those employed in wire transmission. Whether the transmission is telephony, telegraphy, telephotography or television depends solely upon which type of signal is used to modulate the carrying current. If the receiving stations at which "demodulation" takes place are multiple in number, the transmission is commonly referred to as "broadcasting," but this does not change the inherent character of the phenomena. Exactly the same results would obtain with wire transmission if wires ran to the multiple receiving stations.

Because of the wide diversity of conditions of service to be given, and of locations to be served, and the wide variety of transmission means available, choice in any particular case or for any particular service is primarily a matter of economics, and not of fundamental science, of engineering or of theories of governmental regulation. This being so, it is extremely unfortunate for the orderly development of an applied science that means so much in human living, that our thinking and acting should have become so involved in non-existent categories and in the complexities of physical apparatus.

While all forms of electrical communication are merely variant adaptations of common physical phenomena, they can nevertheless be divided for convenience into two groups. The basis for this division is not, however, one of the methods of transmission or of the apparatus employed or even of the kind of service given. Rather it is a differentiation based on our physical senses of sight and hearing.

If at the receiving station the interpretation of the message is conveyed to the brain through the ear in the normal function of hearing, it is telephony; if through the eye, it is telegraphy. Using this basis of distinction, all that we commonly call telephony is telephony; so also is all that we commonly call radio broadcast, whether it be news, music or other forms of one-way electrical transmission of information or entertainment registered through the machinery of hearing. We are not concerned with methods of transmission from the sending station,

except that they be electrical, nor are we concerned with the form or character of any apparatus that may be involved.

On the other hand, using this distinction places all telephotography and television as well as all that we commonly designate telegraphy, whatever its form, in the classification of telegraphy. Here also, methods of transmission and kinds of apparatus are not involved.

If some one should question these definitions on the ground that the signals heard and interpreted by the ship radio operator, or the Morse man at the railroad station, are by them made to constitute these services as telephony, the answer is that these are special cases where the ear of the operator has been trained to do something normally performed by the eye.

Added to the help which classification under these definitions is within the field of electrical communication itself, is the material aid which they give when it comes to relating and judging electrical communication with other forms of communication.

THE KEYS TO THE DELIMITATION OF DISTANCE

Chronologically, as is well known, telegraphy and telephony as here defined developed in the following sequence: wire telegraphy, wire telephony, radio telegraphy, radio telephony, and more recently the beginnings of television. In this they but followed progress in physical research and in the application of mathematical reasoning to physics. Even after Bell's invention of the telephone, long years were to elapse before wire telephony and telegraphy in their technical handling could be treated practically merely as parts of a common art. Long years likewise had to elapse before physical research made practical radio telegraphy a possibility, and still other long years before its advances made possible an extension of this mode of transmission to the field of telephony.

The development of practical radio transmission and the discoveries on which it was based are looked upon as marvelous

advances, and so they were. Largely, however, the measure of the marvel is due to the fact that we had become familiar with wire transmission. If the order of development had been reversed, the discovery of wire transmission by which intelligence could be conveyed from point to point, secretly, with many parallel channels placed close together and using very simple modulating and demodulating apparatus, would have appeared an even greater marvel, when contrasted to a system of limited channel capacity and no privacy except such as might be attained through the use of complex terminal apparatus.

Oddly enough, the advancing knowledge in physics which made possible the adaptation of radio transmission to the requirements of telephony, namely, knowledge of how to produce and control electrons in vacuum, found its first great application in the field of wire telephony. Almost overnight it removed the barrier of distance to voice frequency wire telephony. So powerful was this tool of the electron vacuum tube, taken in conjunction with another great development of mathematical physics which arrived almost simultaneously, namely, the electrical filter, that almost immediately it opened up the entire field of radio telephony and a vast new domain of possibilities in all forms of wire transmission.

In the forty years between Morse's demonstration of a practical wire telegraphy based on the discoveries of Faraday and Henry, and Bell's invention of the speaking telephone, the only practical known method of modulating the line current was by complete interruption. This sufficed for the production of signals at the receiving station which could be interpreted into messages. During these forty years, a great amount of ingenuity was applied to developments based on this form of modulation, and extensive telegraph systems both over land and under the seas came into being for the purpose of expediting the transfer of intelligence hitherto conveyed by mail.

Modulation by interruption was not, however, applicable to

telephony. Bell's invention of the telephone provided a new method of modulation applicable over the frequency range of human speech and hearing. Approximately another forty years elapsed during which tremendous technical and commercial progress based on this new method of modulation was accomplished. Very considerable systems of two-way telephony came into being and, within the limits of their physical possibilities, distance as affecting an interchange of intelligence through speech and hearing was annihilated. The gulf between wire telegraphy and telephony was likewise narrowed by the development of means for providing for both services simultaneously on the same circuit.

There were, however, practical limits of distance to telephony in this period, due primarily to the fact that the strongest modulated current which could be produced by the voice of a speaker became so attenuated by the transmission line as to be inadequate for producing audible signals in the receiver. Prior to 1915, all telephone systems were therefore unconnected islands, large or small, in the universe of speech communication.

In the meantime Marconi, building on the work of Hertz, had demonstrated that practical radio telegraphy could be had by radiating electrical energy of enormously high frequency into space and modulating its flow by the complete interruption method of Morse telegraphy. For fifteen years, however, and despite much research work, there appeared to be no feasible way of employing this new art in telephony.

The situation in the early part of the third decade of the present century was roughly as follows:

1. Wire telegraphy based on interrupted direct current had been in use for approximately eighty years. It had reached a high state of technical development and there were substantially no limits of distance or location to which it could not be extended.

2. Wire telephony based on the use of voice modulated

direct current transmission had been in use about half this time. Commercial two-way telephony had become a vital factor in social and business life but had reached substantially the limits of distance imposed by existing scientific knowledge.

3. Radio telegraphy had made considerable advance, particularly in the marine field and for random services where traffic was sparse or the costs of providing wire line excessive, but was confronted with somewhat the same obstacle as telephony to effective application without regard to distance.

Broadly speaking, the situation in the electrical communication art about 1912 was that of three distinct fields of application—two of telegraphy and one of telephony—which were nearing the limits of their development through engineering application of existing scientific knowledge. Fortunately for electrical communications and for the society it served, fundamental research in atomic and subatomic physics had been going on apace. Out of its results and the equally brilliant results of research in mathematics directed to the problems of electrical communication came the keys which unlocked the confining doors.

The vacuum tubes of Fleming and DeForest and the electrical filters of Campbell were these keys. Neither the vacuum tube, which held the secret of electron control, nor the electrical filter came into the communication art fully grown. Both were embryos, but embryos whose future was clear to those wise in the ways of such embryos.

As a result of appreciation and diligence over a period of less than two years, the research men of the Bell System had so developed these new tools as to push ajar the door of distance blocking wire telephony and the door blocking the application of telephony to radio transmission. Both doors opened on a common passage, and from the time they were opened in 1914–15 there were no longer to be separate compartments for the different kinds of electrical communication.

Development of the vacuum tube gave us first the distortionless amplifier needed to annihilate the distance barrier in ordinary voice frequency telephony, and then the perfect generators, modulators and detectors of high frequency currents needed in radio telephony. Likewise it, together with the electrical filter, opened up to wire telephony and telegraphy the whole field of modulated high frequency currents with their limitless possibilities as compared to mere modulation of direct current. Of course, these new possibilities did not come into being at once and even now, twenty years after the doors were opened, we have in many directions scarcely made a beginning. Even so, however, wire telephony and telegraphy have already at their disposal every scientific or technical device that has utility anywhere in the communication field, and, per contra, radio telephony and telegraphy have many of the tools and techniques of wire transmission. Where a few years ago a single simple channel was limited to one or at most a couple of simultaneous transmissions, we now have the possibility of an equally simple structure accommodating hundreds of non-interfering telephone or telegraph messages, and that without limit of distance.

THE AMERICAN PHILOSOPHY OF SERVICE

The importance of all this to the electrical communication art and to the society it serves lies not in the multiplicity of things we have or may later obtain, but in the fact that there are no longer any breaks in the science underlying the several parts. So far as the physical machinery of electrical communication is concerned, the engineer of the future will have the whole field to choose from and his choice will be determined in each case primarily by considerations of economics or policy and not by those of a limiting science. It is a condition which he must recognize fully. So, too, must those who direct and determine policy and regulation.

Probably in no field of applied science has man gone so far in the organized control of the forces of Nature and in the regimented operation of them in coöperation with human endeavor as in that of electrical communication. Nor is there any other field, I think, where he has gone so far in the way of making provision to avail himself immediately of every new development of fundamental science that may be serviceable. The marvel of even present-day accomplishments is almost beyond belief.

To pick up a telephone anywhere, ask for a friend who may be separated by oceans and continents, and be told to "Hold the line, please," is to stretch credulity to the limit. To talk with that friend as though he were vis-a-vis, to recognize every intonation of his voice despite knowledge that the electrical energy of transmission has undergone hundreds, possibly even thousands of transformations on the way, is to exalt our respect of man's control over the forces of Nature to a high point.

To sit quietly in one's home and hear in full voice words spoken on the other side of the world and to realize that somewhere along the way, possibly several times, the modulated energy which was conveying intelligence to us and to thousands of others simultaneously had diminished to something less than the amount of energy we could collect from the North Star on our outstretched hands, is to take the whole thing outside the bounds of realism.

Or, as we of this Academy did two years ago, to sit in a great auditorium and listen to a symphony orchestra in a distant city render for us music without flaw or blemish and with effects which neither they nor any human orchestra unaided could produce, is to open the doors to a future such as even Jules Verne never contemplated.

Obviously, an achievement so intricate and vast as the whole of present-day electrical communication has been contributed to by many men in many lands. Their contributions have been those of science, invention, engineering, organization and

operation. With full credit to all others it is, I think, no derogation to say that electrical communication is essentially and most largely an American thing—possibly our greatest and most unique contribution in the field of applied science. Certainly both telegraphy and telephony as arts had their beginnings in the United States and, whatever may be argued about the history of telegraphy, there can be no question as to telephony. Born in America, it has always been and is now the leader and model for other countries.

Just why this should be so, it may be difficult to say with exactitude. Other countries have scientists and engineers as well trained and administrators as able, venturesome and far-seeing. Possibly our lack of tradition and settled modes of life had something to do with it; possibly the adventure of it appealed more strongly to us; possibly it fitted better the tempo of our times; and possibly the fact that it had fifty years in which it could grow and develop essentially untrammelled by a too narrow and detailed dominance of political government was a major influence. Certain it is that, with few exceptions, telephony elsewhere has from its inception or after a brief initial period been either a function of political government or completely dominated by government. Inevitably, it has been subjected to all the restraints which seem to be a necessary concomitant of such government. In a developing art based on a rapidly growing fundamental science, it is fatal to progress and to the fullest fruiting for society to begin setting rigid standards, rules and regulations before you know what it is you are trying to standardize, rule and regulate and before that art has reached the quiet courses of mature life.

But above and beyond all the reasons which may inhere in these factors, it seems to me that the principal explanation of American preëminence in the field of telephony resides in the fact that from the very earliest days of development we have had a definite philosophy and have sought in every way possible to adhere to it. It is a philosophy compounded of faith

in the ultimate possibilities of science and engineering; of a belief that a universal telephony was a powerful and necessary tool for society; of a realization that maximum development of usage required the best possible service the art permitted, at the lowest possible price commensurate with cost and a fair return to those who gave the service. As indicative of the objective of this philosophy, a quotation from the charter of the American Telephone and Telegraph Company, granted March 3, 1885—more than fifty years ago and less than ten years after Bell first exhibited his telephone at the Centennial Exposition—may be illuminating:

And it is further declared and certified that the general route of the lines of this association, in addition to those hereinbefore described or designated, will connect one or more points in each and every city, town or place in the State of New York with one or more points in each and every other city, town or place in said state, and in each and every other of the United States, and in Canada and Mexico; and each and every of said cities, towns and places is to be connected with each and every other city, town or place in said states and countries, and also by cable and other appropriate means with the rest of the known world, as may hereafter become necessary or desirable in conducting the business of this association.

To appreciate fully the faith and daring of these words, it should be remembered that at the time they were written telephony was an infant thing of small utility and limited scope and that the things of science on which its future was to rest were as yet unborn.

While the philosophy has been primarily that of the Bell System, it has in its main aspects been the guiding principle of all who have sought to develop telephony in the United States. The result is an essentially unified service, despite diversity of ownership. Nowhere else, so far as I am aware, is electrical communication dominated by such a philosophy.

Implicit in the philosophy and explicit in its application for more than fifty years is the ideal of service as a means to an

end, of faith in the ability of science to develop and electrical communication to profit thereby, of a catholic attitude toward any and all means by which service may be extended and improved, of an avoidance of any and all fixed standards which tend to hamper and limit progress and render development their slave rather than their master, and of a belief that men are capable of building up and maintaining a vast and efficient co-operative organization of men and women imbued with and actuated by a common ideal. In operation here in the United States every function of research, engineering, manufacture, installation and operation, of finance, public relations and management, is tested against this philosophy. While enormous progress has already been made, the end of the road is not yet in sight. Principal in the work ahead is the job of science, for while an operating organization can easily fail to get the most out of its physical tools, it can never get more out of them than they contain.

While never specifically enunciated as part of the philosophy, there has nevertheless been from the beginning of telephone development in America a factor inherent in the definition of "best possible service" which for many years and until quite recently directed the growth of American, and at least the larger part of foreign, telephony along divergent paths. In recent years, foreign practice has tended to conform more nearly to that of the United States.

From very early days the American conception of telephony as a "service" has been that of something to be furnished on demand and as nearly instantaneously as possible—not as something to be furnished at the convenience of the purveying organization. The goal of an ideal service has always been that of a "no delay" service, where the two parties are put in communication immediately following the request of the originating party and while he remained at the telephone. Since the normal processes of our daily lives—our waking and sleeping, our business and social activities—are not uniformly distributed

throughout the twenty-four hours, they tend to concentrate our communication desires in certain peak periods. Strict adherence to the "no delay" principle in these peak periods means, therefore, inevitably the provision of much plant which must lie idle the greater part of the time, with consequent greater cost against each unit of usage than if the usage could be more uniformly distributed. It avoids, however, any tendency of the communication machinery to impose artificial restraints on the normal currents of human affairs. It also admits of a simple uniform rate structure without any urge to establish preferred classifications of service.

From the scientific and engineering point of view, it is this "no delay" objective for all telephone calls, more than anything else, which has imposed the greatest incentive and stimulus to intensive research and development. Obviously, a universal "no delay" service can be obtained only if the physical means of communication are so cheap and reliable as to permit a profusion of plant sufficient to accommodate peak traffic without imposing an excessive burden of cost on the user.

While we are still a long way from the ultimate objective, we have during the past ten or fifteen years made appreciable progress, especially over the longer distances, and that too with a diminished cost of service to the subscriber. Except for accidents, substantially every telephone connection anywhere in continental America, whether one calls by number or for a particular person, is now established while the calling party remains at the telephone.

Contrasted with this "no delay" objective was the objective of maximum use of physical plant which for so long dominated most telephone development outside of the United States. While this was intended to reduce unit costs, it opened a Pandora's box and let loose a host of unforeseen difficulties and irritations. It occasioned interminable delays which sometimes amounted to hours on relatively short distance calls, with consequent irritation. To overcome this trouble is necessitated

the introduction of successive classifications of service, each more expeditious and more costly than the others, until for "no delay" service the charges were materially higher than those for the same distances here. At the same time, service at the base rate charge, except at off-peak periods, became unutterably poor.

Finally, the whole scheme acted to force users against their will to bend their normal actions to fit their communication tools, rather than the reverse. Fortunately, the achievement of science in cheapening facilities, combined with its achievements in producing means for worldwide telephony, with consequent necessity of uniformity at the highest level and a revulsion against an intolerable situation, has now established a reasonably consistent criterion, to which most countries are working.

I have dwelt somewhat at length on these phases of telephony, partly to show the far-reaching effects of adherence to right or wrong concepts on the growth of an art and of the dominant influence of scientific research and engineering in establishing those right concepts; partly to emphasize a fundamental difference between the major aspects of telephony and telegraphy. Within relatively wide limits and except for special cases, there is no necessity for "no delay" service in telegraphy. Inside these limits, technical endeavor to cheapen the means of transport is little if at all influenced by elements of delay.

DISTINCTIONS BETWEEN TWO MODES OF TRANSMISSION

With these considerations of philosophy behind us, a brief view of where the world stands in the year 1935 as regards the science and art at its disposal for telegraphy and telephony, and the use it is at present making of them, may be helpful.

In the matter of science and art, all forms of transmission of electrical energy, whether wire or radio, are potentially available for any and all forms of telegraphy and telephony.

Choice of transmission means in any given case, except to mobile terminals, is essentially a matter of costs, reliability, density and character of traffic. Broadly speaking, radio transmission is a non-secret broadcasting method of conveying intelligence, while wire transmission is a secret method confined narrowly to the terminals connected to the wire channels. In radio transmission, the number of non-interfering channels within any transmission range, though possibly large, is finite, while the number of wire channels is essentially infinite. Privacy in radio transmission can be obtained only in the special design of essentially complex terminal apparatus and can never be strictly secret. On the other hand, wire transmission (barring actual wire tapping) is essentially secret without selective design of terminal equipment. From its nature and the nature of the terminal equipment needed to "modulate" and "demodulate" the transmitted energy, radio transmission is essentially unadapted for services such as ordinary telephony where random connection between any of a very large number of terminals is involved. Wire transmission, on the other hand, is ideally suited to such service.

There are, of course, many minor considerations which influence determination of means in any given case, but broadly speaking, it is the major characteristics which bring about final decision. Neglecting special cases or cases of use which persist because of historical reasons in the commercial development of the art, present-day electrical communication in its major usages conforms to these major characteristics.

Wire transmission is indicated where privacy of communication between indicated terminals is required, where traffic density is high and maximum reliability of service is a prime desideratum, or where instantaneous switching between a large number of terminals is involved. In most of these cases, also, consideration of over-all costs weighs strongly in favor of wire transmission.

Radio transmission is indicated where broadcast dissemina-

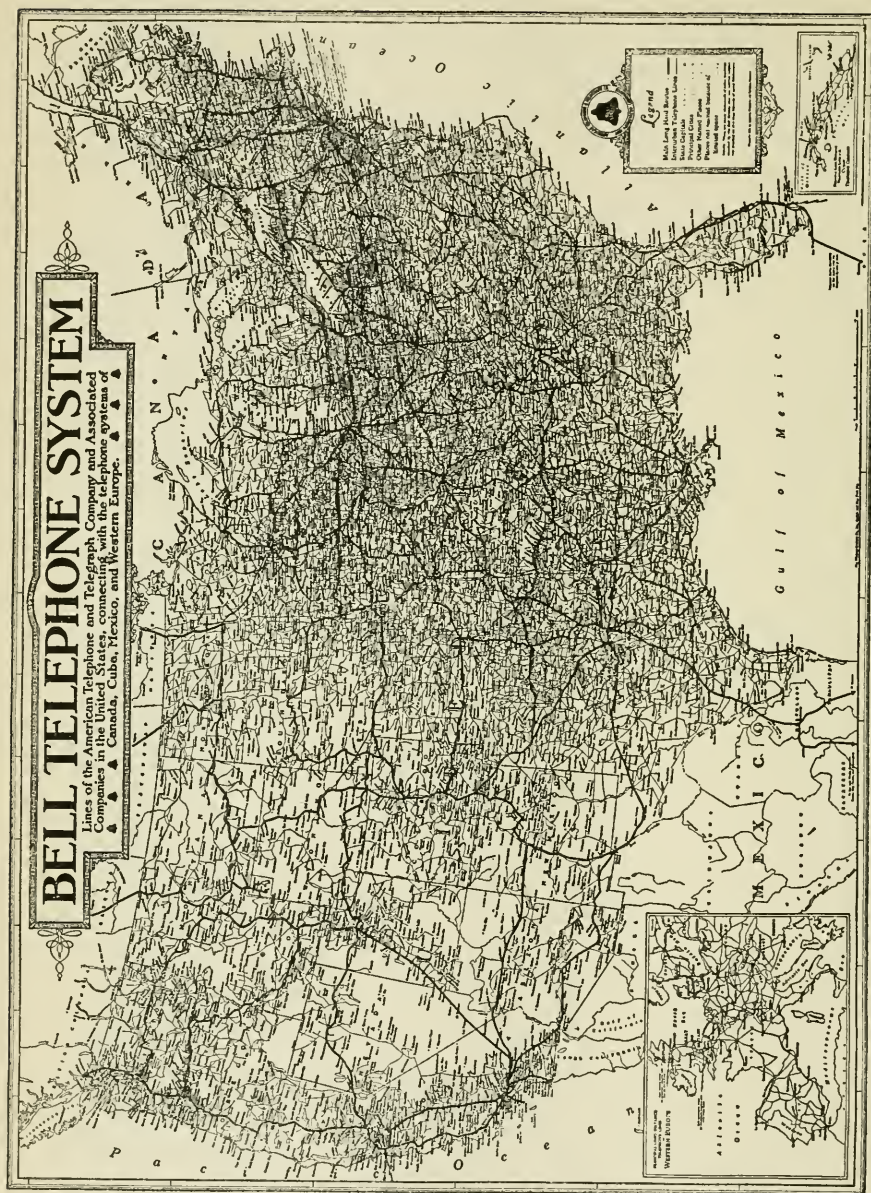


FIG. 1. THE BELL SYSTEM'S NETWORK OF TOLL AND LONG DISTANCE TELEPHONE LINES WHICH CRISSCROSSES THE UNITED STATES.

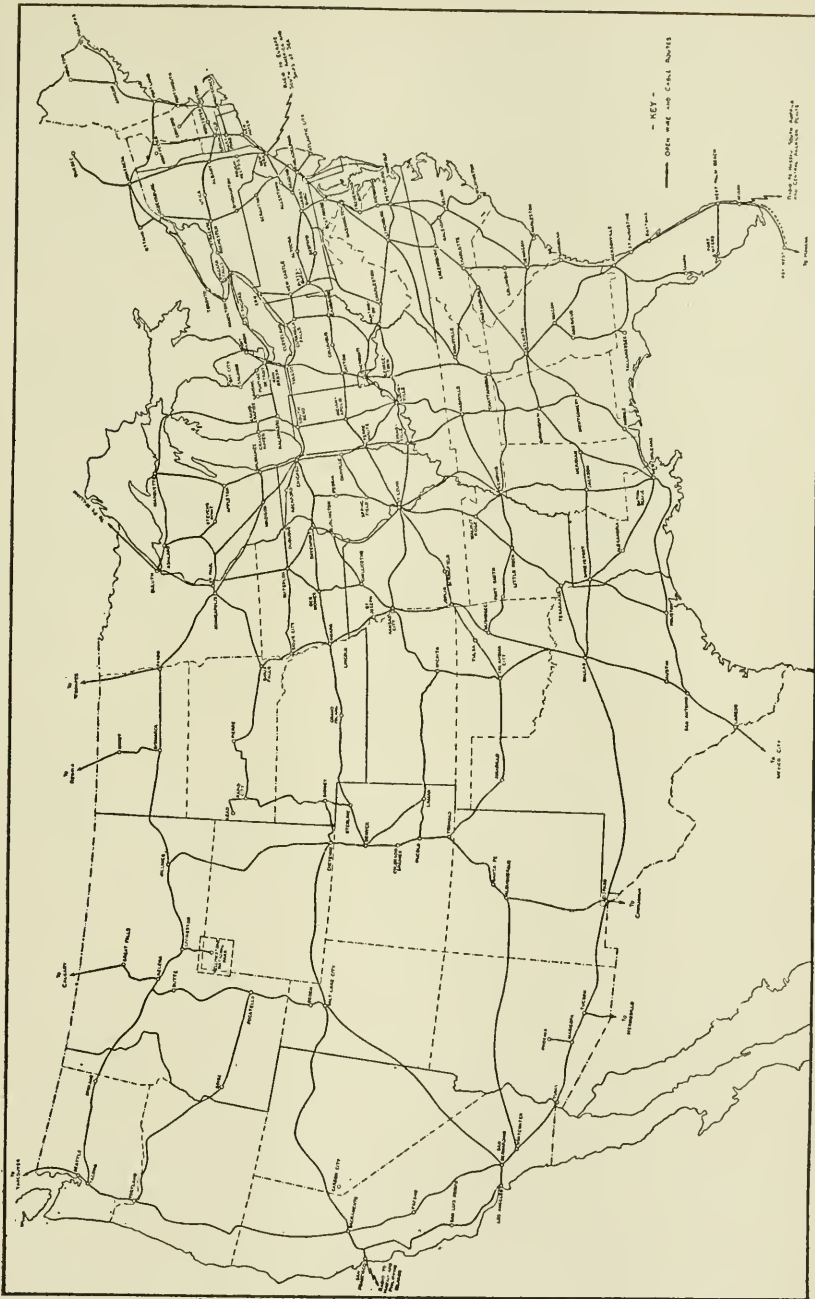


FIG. 2. CERTAIN LONG-HAUL ROUTES OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY.

tion of intelligence is desired and where reliability of service, though desirable, is not essential. It is likewise indicated for transmission to designated terminals where the intervening distance is over water or over long stretches of difficult terrain, particularly over routes where traffic density is low and irregular. It is, of course, uniquely indicated for the transmission of intelligence to mobile terminals, such as ships, airplanes and moving vehicles.

Thus it is that practically all of the world's ordinary telephone communication and the larger part of its regular telegraph communication is handled by means of wire transmission, with radio transmission playing an auxiliary and minor role. Per contra, practically all of a one-way dissemination of news, music and entertainment and much of ordinary telephony and telegraphy over very long low density traffic routes is provided by radio transmission, with wire transmission playing an auxiliary role.

A SERVICE WORLD-WIDE IN ITS EXTENT

To give you a simple visual picture of how completely our present-day world is gridironed by its communication channels, the following figures may be of assistance. I have chosen these merely to give you first an idea of the completeness with which the people of the United States have been provided with telephone service and of the main traffic arteries over which this service is given (Figures 1 and 2).

Likewise, I have shown in Figure 3 the principal telephone arteries of Europe, in Figure 4 the principal radio telephone trunks which connect the principal telephone systems of the world, and in Figure 5 the principal submarine cable telegraph arteries of the world. Unfortunately, it did not seem feasible to prepare a chart showing the established radio telegraph routes, since these are obviously almost as numerous as the numbers of pairs of places where transmitting and receiving equipment is provided. In the main, however, the total

ELECTRICAL COMMUNICATION

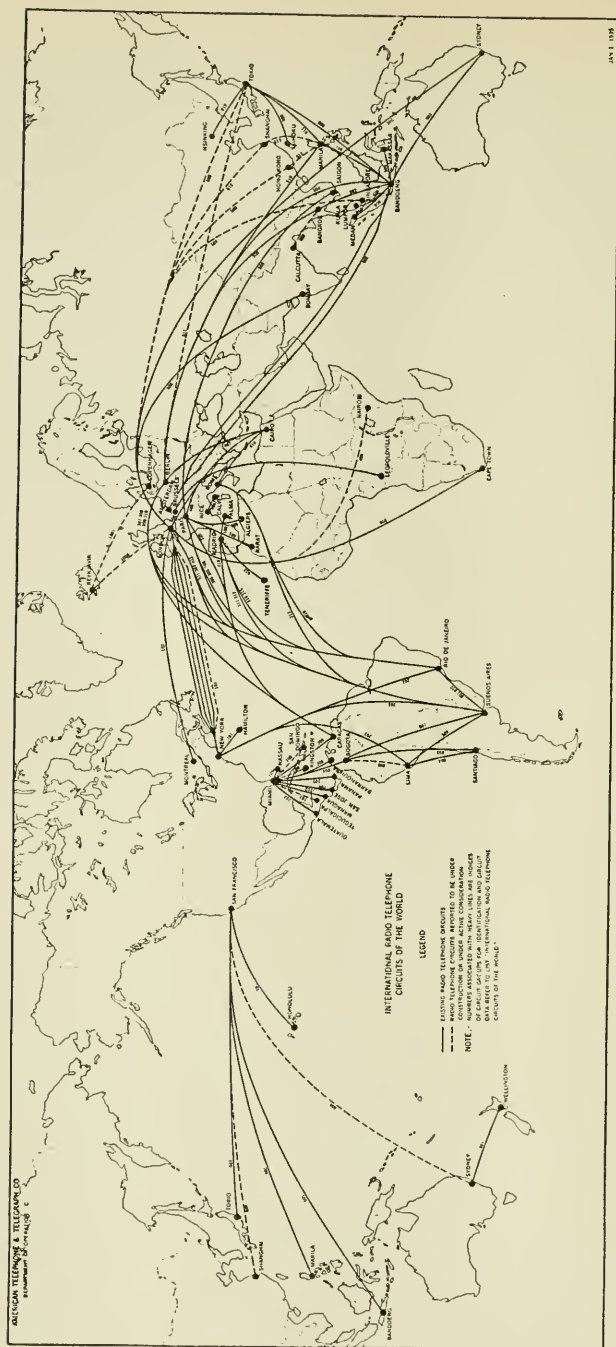
amount of telegraph traffic handled over the routes of this vast network is not great.

Obviously, also, it is not possible in a diagram of this kind



FIG. 3. THE TOLL TELEPHONE CABLE ARTERIES OF EUROPE.

to depict the situation of such a thing as radio broadcasting. Radio broadcast of news, music and entertainment is commonly thought of as primarily a utilization of radio transmission. So it is, in the transmission from the radio broadcasting station to



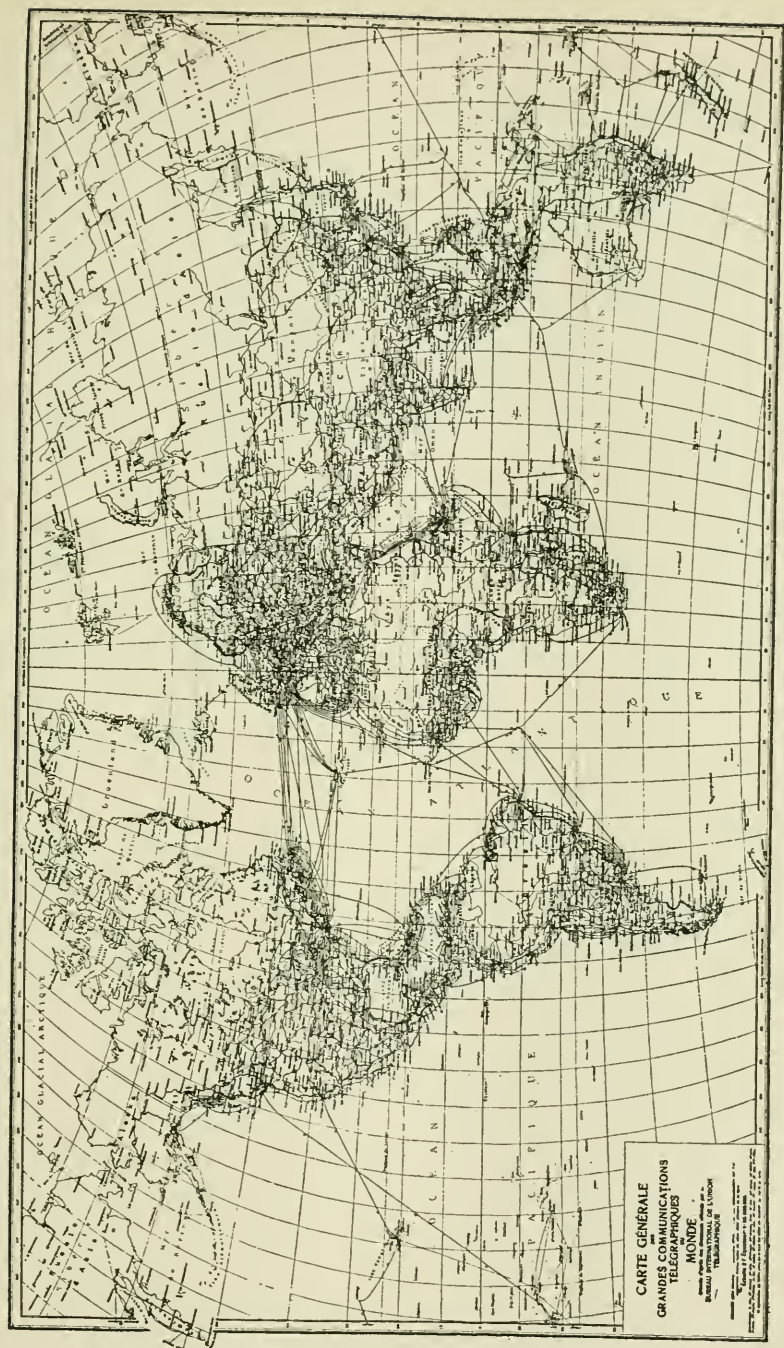


FIG. 5. THE PRINCIPAL SUBMARINE TELEGRAPH CABLES THROUGHOUT THE WORLD.

the numerous radio receiving sets which may be within the transmission radius. In every case, however, preceding the first stage of high frequency transformation at the broadcasting station and following the last stage at the radio receiving set it is wire telephony. In the simplest case of an isolated broadcasting station where the source material is from a studio at the station or from a terminal in the immediate neighborhood of the station, the amount of wire transmission may be small. When, however, we come to consider chain broadcasting, with many broadcasting stations connected to a common studio or other program source, the conditions are materially altered and the radio portion becomes in effect the terminal distribution of a large and frequently complex wire transmission network. Going further still, to the case where the program source is in a distant continent, the transmission channel to the final radiating broadcast stations is a combination of wire and radio transmission. (Figure 7 shows some of the wire broadcasting networks in the United States.)

Now just a few statistics, and the main outlines of the picture of our present situation will be complete.

In magnitude and importance in the field of electrical communication, ordinary telephony is the giant of the services. At the beginning of 1934 there were a total of approximately 32,500,000 telephones in use in the world. Of this number, approximately two-thirds were operated by private companies and the remainder by governments. Approximately 51 per cent of the world's telephones were in continental United States and approximately 56 per cent in North America. These figures in themselves do not, however, give any vivid idea of the relative importance of two-way telephony in the social and business life of different countries. A better figure for this purpose is to relate the number of telephones per hundred of population in the several countries (Figure 6). With this yardstick, development in the United States at the beginning of 1934 was 30 per cent higher than the corresponding figures

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for New Zealand and Denmark and 40 per cent higher than that for Sweden, which outside of North America were the next highest. As will be seen from the chart, it was many

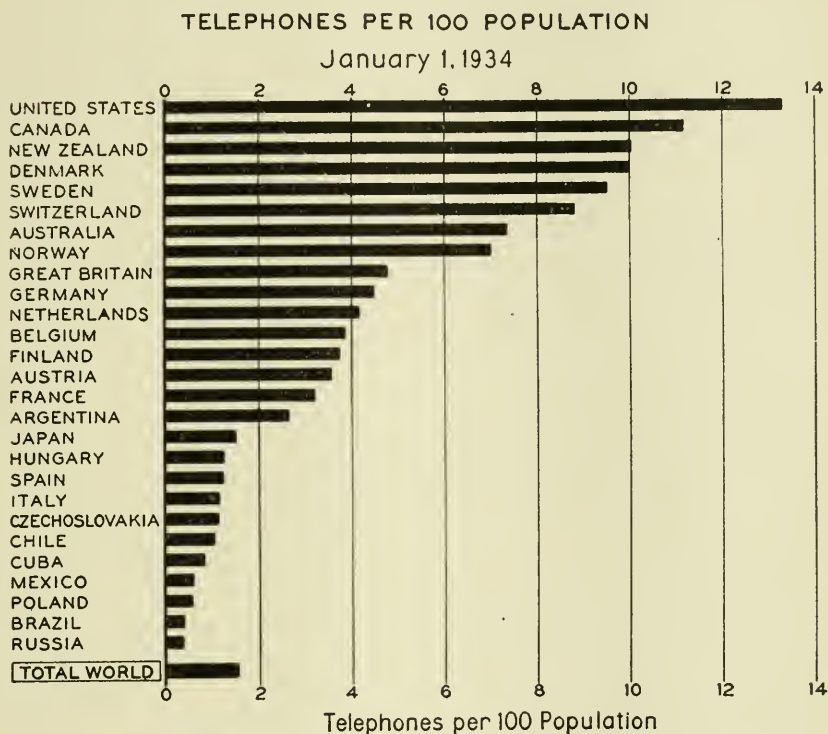


FIG. 6. TELEPHONE DEVELOPMENT OF THE NATIONS OF THE WORLD ON A POPULATION BASIS.

times the average of that for the civilized world outside the United States.

Another vivid illustration of the extent to which we in this country have gone in our adoption of the telephone is to point out that there are in the metropolitan area around New York City almost as many telephones in service as in all of Great Britain and Northern Ireland combined.

Illustrative of the fact that ordinary telephony is the giant of the regular communication services, is the fact that in 1933

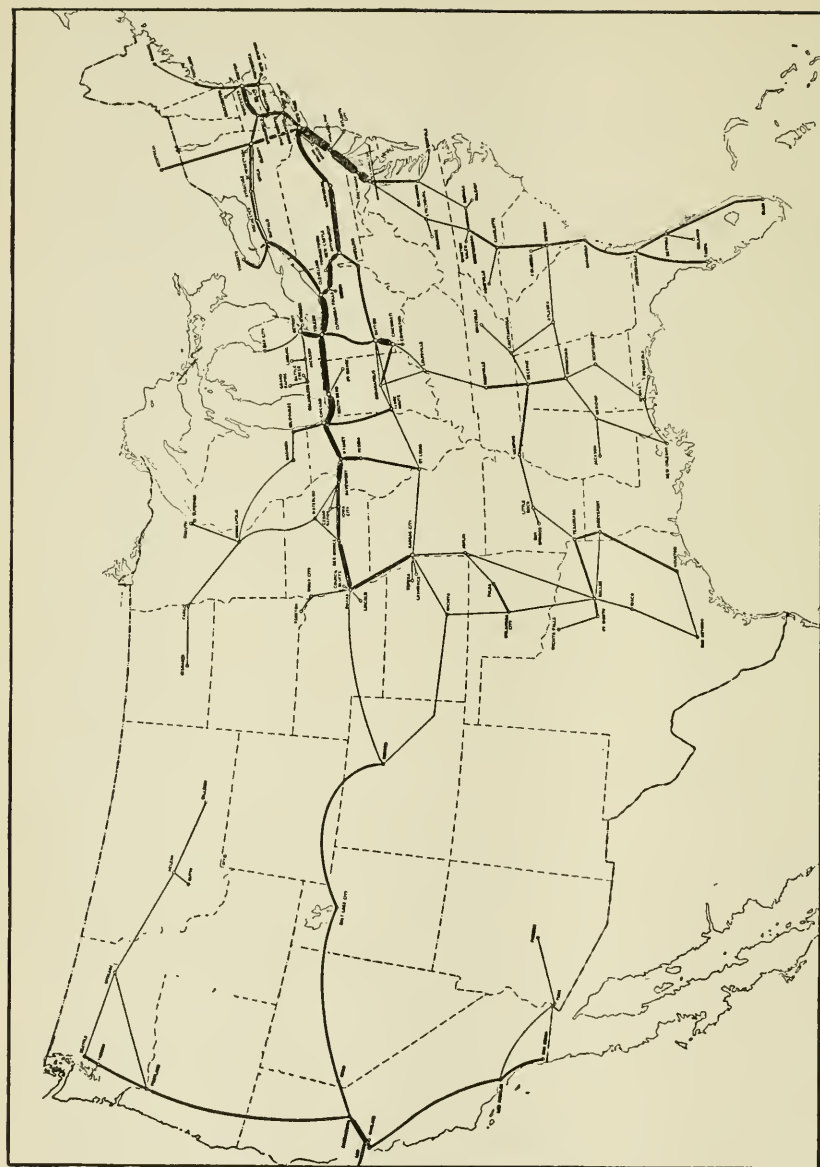


FIG. 7. SOME OF THE TELEPHONE TRANSMISSION LINES FOR CHAIN BROADCASTING IN THE UNITED STATES.

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there were established in the United States a total of more than 24,000,000,000 telephone conversations and in the rest of the world approximately 21,000,000,000 conversations. Compared with this were totals of approximately 145,000,000 telegraph messages in the United States and 750,000,000 telegraph messages elsewhere. In other words, merely on a message basis comparison there were about fifty times as many transfers of intelligence through electrical means by telephony as by telegraphy.

Of the stupendous amount of radio broadcasting of news, music and entertainment which has developed in the last decade, there is of course no way of estimating in any units such as can be employed for ordinary telephony and telegraphy, nor is there any way of picturing the distribution of such broadcasts. Because it is broadcast in nature, each transmission can be picked up by anyone within the range of transmission. Numbers of broadcasting stations, probable numbers of radio receiving sets and approximate amounts of money involved we may know something about, but as to the magnitude of the traffic or as to its effects on society, we have no yardsticks. All we do know is that it has come to be a vast thing and that we are still in the experimental stage of its usage.

So much for the present; and now a word or two about the future as it appears to me. I say "as it appears to me" advisedly, because when it comes to dealing with the unknown future—even that of a narrow field—no two people are likely to have precisely identical views, even though they start from the base of a common understanding.

THE DIRECTION OF FUTURE DEVELOPMENT

First, as to the general question which is frequently asked, as to whether one form or other of electrical communication may not develop such a dominance as practically to eliminate its competitor, it seems clear that the answer is "no." It is true that in the past fifty years telephony, because it was a newer

art, has developed much more rapidly than telegraphy and, in some sectors, at the expense of its rate of growth. It may and probably will continue, for some time to come, to grow more rapidly and possibly even in some directions at the expense of telegraphic growth. At the same time it is clear from past experience that whatever tends to facilitate interchange of intelligence tends to stimulate growth in all of the various means by which intelligence is transmitted. Added to this general tendency is the further fact that new forms of telegraphy, that is, forms of electrical transmission which are appraised through the eye, have come into the picture. Also, many of the scientific developments which are acting to advance the art of telephony are automatically benefiting the art of telegraphy by cheapening, simplifying and expediting its machinery.

If there is serious danger to telegraphy, it resides, I think, not so much in other forms of electrical communication as in entirely different methods of transporting the permanent records of which telegraphy is the electrical carrier. In brief, the principal danger, if there is one, would seem to lie in the realm of air transport. Unless, however, this danger is more real than I think it is, and unless telephony in one form or another develops to such an extent and produces such a revolutionary change in the methods of life as to eliminate necessity for the written record, there would appear to me to be no likelihood of telegraphy following the course of the ancient galley or of the sailing ship.

I have earlier mentioned that telephony and telegraphy have come to be parts of a common science and art where advances in one field may and frequently do find immediate application in the other. Since telephony is the more general case of electrical communication, it is natural not only that more of scientific attention should be paid to its problems but likewise that the greatest changes from the existing art are likely to result in it. There are, of course, some things which once done, remove completely the existence of a problem. For example, neither

in telegraphy nor in telephony will we ever again have to cope with the problem of overcoming distance. No matter how poorly we may be doing it at the present time, we nevertheless do know how to extend telephony and telegraphy between any two points on the earth's surface, and we are prepared to make this extension promptly if necessity arises. Likewise, we do know how to make substantially instantaneous connection between communication channels when these connections are desired in any random fashion.

Within these and similar limitations there is, however, still a great amount of research, development and practical application work to be done before we approach the limits of a completely comprehensive or completely adequate electrical communication service. Many of the things which we are now doing and will continue to do are done poorly when measured with the yardstick of what we know to be attainable or what we would consider to be wholly satisfactory. Vast though it is at present, electrical communication, and particularly telephony, is still far from being a universal service of maximum utility, even in a country as strongly telephone-minded as is the United States. How far the present is from an attainable future is evidenced by the figures quoted earlier as to present usage here and in the rest of the civilized world. Telephony is peculiarly an art in which the value of the service increases rapidly with the number of places and people who can be reached substantially instantaneously. We may never have occasion to want to communicate with some one at some distant point, but then again an occasion may arise where it is a matter of the utmost importance to be able to speak with some particular person at some particular spot and at a particular time.

Technically we seem about to enter a new era in the development of means for providing great numbers of transmitting channels economically for our longer distance routes. Through intensive research it has been possible to devise a simple form of cable and a means of transmission by which literally hun-

dreds of telephone channels can be obtained in a structure no larger than one's finger. Moreover, this structure is capable of transmitting the enormously wide frequency bands required in television—that newest of developments in telegraphy. This result marks the present stage of the advance which started twenty years ago as a result of the introduction of the vacuum tube and the electrical filter. Where the end of the road is, no man is wise enough to say. Nor is anyone wise enough to forecast what may be in store for us as we continue to find useful applications to electrical communication of the flood of new knowledge which continues to flow as a result of our delving further into the secrets of Nature.

In what I have said this evening, I have had in mind primarily electrical communication as an art. I have not had in mind those occasional transmissions of intelligence by electrical means which are not infrequently reported. When we read in the paper that Willie Smith in Brattleboro, Vermont, has conversed with Johnnie Jones in Sydney, Australia, using a home-made short wave radio set of small capacity, we are not considering electrical communication in the sense I have been considering it. Electrical communication, to be an art in the sense here under discussion, is much more than an occasional or fortuitous demonstration of scientific possibilities. It is a thing which must be available with a high degree of regularity to those who would use it. It requires for its giving, great co-ordinated service organizations. Unless it is regular and reliable, it may be useful on occasion but it can never influence largely the scheme of men's social and business intercourse. From a scientific and engineering standpoint it is apparent that our future course will result in structures and systems by which every form of electrical communication can be given over a plant which is largely interchangeable and readily adaptable to changing service requirements.

Since complete development of telephony hinges upon the production of physical things of very great efficiency, very low

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cost and of extreme reliability, it is peculiarly a problem for science and engineering. We have already gone far enough in science and engineering to have a sufficiently accurate view of the future to be able to say with practical certainty that, given the opportunity, science and engineering can produce for society all of the communication tools it may need to extend electrical communication in any desired form as far as the normal requirements of society may dictate.

FRANK B. JEWETT

The Changing Years as Seen from the Switchboard

Editor's Note:

The interviews appearing under the above title in current employee magazines of the Bell System are reprinted here as affording an interesting supplement to "Opportunities for Women in the Bell System" which was published in the BELL TELEPHONE QUARTERLY for January, 1932. Previous installments have appeared in the QUARTERLY for January and April, 1935.

V. TRAINING METHODS—THEN AND NOW

Readers of the last installment of this series of interviews will recall that it closed with a question put to Miss Katherine Schmitt regarding methods used in training operators for their work when she began her career at the switchboard in New York in 1882.

"Well, in the very early days, we learned what we learned without a great deal of teaching," was her reply. "In going over this material which has been collected from the women who were operators, as I was, in the Eighties, you have noticed, I suppose, what they have to say about how they learned their part in the telephone business? Well, their training methods were just about like what we got—what I got when I went to work in the old Nassau office, in New York, fifty-three years ago."

It would be possible to select, at random, from the several hundred replies to the questionnaire sent to these pioneer operators, a description of training methods that would be typical of practically every central office in the country at the time. One of the most graphic of these descriptions is that by Mrs. Margaret Mackin Hyatt, of Chicago, whose words regarding the opportunities for women in the telephone business in its early days were quoted in a previous interview.

"Our training," says Mrs. Hyatt, "was brief and was about as follows: (She obviously quotes her instructor, whoever he or she may have been) 'This is the switchboard; this is a plug; and this is a jack. When a drop falls, you will plug into the jack directly under the drop and speak into this part of the telephone (it is called the transmitter) and put this part to your ear (it is called the receiver). You will give your number, which is 36, and the subscriber will give you either the name or number of the party he wants. If he gives you the name, look the number up in the directory, write both numbers on one of these tickets, and pass it to the operator directly behind you, who will complete the connection.'

"Unfortunately for me," Mrs. Hyatt adds, "the tone of voice to use was not mentioned, and as a result there was no doubt a startled subscriber when I yelled my number, and promptly received my first reprimand from an irate manager."

Almost invariably the new operators were seated beside more experienced girls and given headsets so that they could listen-in while the latter were at work. After a day or two of this, supplemented by such oral instructions as the older operators could give the recruits, the new girls were given a little operating to do during periods when the traffic was light. After an indefinite assignment at this part-time operating, they were informally graduated to full-time operating. That was substantially all the training that was given operators in the pioneer telephone days.

"Yes, that was about the way things were done in New York when I started work," comments Miss Schmitt. "It was all very informal—but it was also very personal, and when a new girl fell into the hands of an older operator who really took an interest in her, as was usually the case, she made remarkably rapid progress."

Telephone Service Becomes More Complex

As use of the telephone became more general and the amount of traffic increased, the problems involved in providing telephone service became more complex. These informal training methods became inadequate—partly because of the necessity of working more rapidly in order to keep abreast of the calls that came into the central offices, and partly because new apparatus was developed which could handle this increased traffic more efficiently, but which could do so only when the operators thoroughly understood how it was intended to function.

Many of the telephone companies issued printed or type-written "Operating Rules" with which the girls were expected to familiarize themselves, and, in some cases, to learn by heart. Some of these, however, did not deal so much with operating practices as they did with the organization and discipline of the central office.

Perhaps the most important step toward more efficient work at the switchboard was the introduction of the present set-up of a chief operator and a number of supervisors in each office. The supervisors not only assisted the operators in their work, but actually continued their training, thus supplementing the preliminary instruction they had received. The use of supervisors did not become general throughout the Bell System until the late nineties or the beginning of the present century.

Another milestone along the road that has led to the high degree of operating efficiency which now characterizes Bell System central offices was the establishment of the first operators' training department by a telephone company—one of the pioneer steps in vocational training, which has become widespread, not only in the telephone service but in many other industries.

The First Training Course

Miss Katherine Schmitt was the first manager of this training department or school and, on the subject of this phase of

the training of telephone operators, speaks with an authority founded on long years of personal experience. Much of the information which follows is founded on her recollection of her training work, in which she was engaged as manager of this school, from 1902 to 1925, and as supervisor of training schools for the New York Telephone Company, from 1925 to 1930.

The need for such a training course, it would appear, had been felt for some time by the management of the Metropolitan Telephone and Telegraph Company (now the New York Telephone Company). The establishment of the school was, however, delayed until January, 1902, by which time the change from the magneto to the common battery switchboard had been completed in all central offices in New York City.

The theory on which this school was based closely followed that which was generally accepted in educational circles at the time. There was a definite emphasis on classroom work, to which practice on the switchboard was supplemental. The equipment of the school accordingly consisted of a room furnished after the manner of a typical school room, which was used for what amounted to lectures and for study periods, and an operating room. The latter duplicated as nearly as possible the equipment of an actual central office, with a twelve-position switchboard, a chief operator's desk, listening-in equipment, and so on. In addition to the manager and a chief operator, the staff consisted of a number of supervisors, all of whom were given preliminary training in their duties as instructors before the school was opened.

Routine of the course included presentation, in the classroom or at the switchboard, of the operating instruction to be learned for the day; follow-up instruction and practice at the switchboard, the supervisors putting through from their desks calls involving the particular points covered in the day's lesson; and considerable time spent in study in the classroom.

Within a relatively brief space of time, the establishment of this school in New York was followed by the opening of similar

training courses in Chicago, Philadelphia, Boston, Denver and elsewhere throughout the Bell System. The facilities for training provided in the smaller cities and towns were, of course, less elaborate than in the more populous centers, but their courses were based on substantially the same principle as those of the metropolitan areas. Many thousands of telephone operators have received their preliminary instruction in these courses.

New Educational Trends

While the development of these courses was under way, there had begun, in educational circles generally and in vocational education in particular, a trend toward a closer relationship between the preparation for a job and the job itself. Many a student, trained under the system in which emphasis was put primarily on classroom work, found great difficulty in passing through the period of transition from training to actual work. Many a telephone operator found that there was a vast degree of difference between a training course classroom or a practice switchboard and the job of handling a position in an actual central office—a difference which became the more marked as more emphasis was given to what may be called the school atmosphere.

To meet these difficulties, the training of telephone operators has moved into another phase—a phase which, in some particulars, is reminiscent of the old days when a new recruit learned her job by sitting at a switchboard and doing it, under the guidance of an older or more experienced operator. But the present system of training is not simply a return to the methods of pioneer days—it is such a return, plus all that it has been possible to learn about education and about the telephone business in half a century.

One of the best informed men in the Bell System on this phase of the training of telephone operators is Henry C. LaChance, of the Department of Operation and Engineering,

American Telephone and Telegraph Company. To him the writer went for some first-hand information on training methods now followed throughout the Bell System.

"Our training to-day," begins Mr. LaChance, "attempts to prepare the student actually to perform her specific job, and to give this preparation in a manner that is just as agreeable to her as we can make it, with a maximum of job atmosphere and a minimum of school atmosphere.

"You know," he continues, with a smile, "a lot of telephone operators—like a lot of other young women, and a lot of young men, for that matter—take a job because they are tired of going to school. Well, we have found that we can't successfully send a young woman like that to school when she applies for a job. What she wants is a job, and we try to make her feel that she has one. That's what I mean by 'a maximum of job atmosphere.'

Learning the Job on the Job

"On a girl's very first day with the telephone company, she is given a position on the switchboard at which she is to work. The rise and fall of traffic in all of our offices makes it possible to find positions which are not in actual use, so that they may be assigned to these new operators. At either side of the newcomer are experienced girls, busy with their work. The position to which she is assigned is identical with the others at the board and has, in addition, a key which protects the service against disturbance by practice calls.

"After the new operator has been seated at this position and given some informal instruction as to the handling of calls, a specially trained operator takes another position at the board—known as a 'control position'—from which she can simulate the calls that will have to be handled by the new operator when she is given an actual working position. Under the guidance of her instructor, the student operator sets up these calls, which are in every respect like actual calls. After she has become

proficient in this—and, incidentally, the training period is now considerably shorter than formerly—she is given an opportunity to handle actual calls during light traffic periods, and thus works into her job, almost without being aware of it.

“This process of ‘learning by doing’ is supplemented by discussion of operating practices and drills which may best be conducted away from the switchboard. Classes are held, but the groups of students are smaller than those in the training courses we formerly gave, and an effort is made to keep the atmosphere of these classes informal—in fact, we like to think of them as discussion groups, rather than as classes.

“The emphasis in our training work, however, is placed on practical training at the switchboard, rather than upon classroom work, though both are important. And both are designed to meet the requirements of the particular central office in which the operator is to work. The process of fitting the training to the job has been facilitated by a recent development which we consider most significant. This is a plan for analyzing the work which must be done by an operator in any particular office. In effect, the overall job is broken down into separate steps, so that the essentials of any operating job may be determined with scientific accuracy, whereas formerly this was attempted on a basis of judgment. The result has been a much closer adjustment of the training effort to the actual job in each case. Today, our people take it for granted that the first step in formulating a training plan is to find out what the job really is—not as written in a book but as actually performed at the switchboard.

“I cannot emphasize too strongly the advantages of carrying on this training, as we now do, right in the central office where the operator is to work when her training is completed. From her very first day, she becomes accustomed to the atmosphere of this particular office, and becomes a part of it. As all telephone people know, traffic conditions and service requirements vary widely in different central offices. Under our present sys-

tem, the training in each office is particularly suited to the requirements of that office, as determined by the analysis to which I just referred.

"Training is Never Finished"

"Moreover, we make a point of continuing the training, even after a girl has been given actual traffic to handle. A moment ago, I used the expression 'after her training is completed.' I'd like to correct that—you see, an operator's training is never finished. One of our objectives is to give her the opportunity of always learning to do her work better. Having the preliminary training done in the office where she is to work makes this continuation of her training much simpler. The opportunity for self-improvement doesn't involve 'going back to school' or taking what might be called 'post-graduate' courses. Rather, it consists in seeking and receiving assistance from a competent supervisor in learning the refinements of the job while working at it. In other words, the operator's job and her training for it have been brought so closely together that the two are, in effect, parts of the same activity."

These words of Mr. LaChance—this idea of bringing the job and the training for it as closely together as possible—come near to summing up the whole philosophy of the Bell System's training of its employees, operators among them. Methods change—including training methods—but purposes remain constant. To give the best possible service at the lowest possible cost is the first and most fundamental of the purposes which lie behind Bell System methods. Whatever may be the training methods of the future, this much is certain about them: they will be directed toward the single objective of helping the telephone operator to do her work in the best possible way.

VI. A SOUND MIND IN A SOUND BODY

"A sound mind in a sound body," wrote a Roman poet, nearly nineteen hundred years ago, "is a thing to be prayed

for." Hardly more than a century before this, in Galilee, another principle had been proclaimed: "All things whatsoever ye would that men should do to you, do ye even so to them."

Generations came and went, each quoting these two sayings separately, apparently without dreaming that they might be related. Individuals prayed for, and sought in other ways to find—for themselves—the much to be desired combination of mental and bodily health which Juvenal had commended. It seems almost never to have occurred to them that one form of applying the Golden Rule was to seek a sound mind in a sound body for others.

Specifically, it rarely occurred to an employer that there might rest upon him an obligation, other than that of self-interest, to care for the health of his employees. While Rome held sway, most of the world's work was done by slaves; throughout the age of feudalism, it was done by serfs who were little better than chattels. Long centuries elapsed before employers learned that proper care for the health of their employees was both good business and good morals. Even after this fact had been fairly well accepted, many years passed before any real progress was made in the direction of promoting the health of workers.

A Business Newly Created

Sixty years ago, when the telephone was born, the movement toward more wholesome and healthful conditions for employees in industry and business was still looked upon as an innovation. Even in long established enterprises, only a few forward-looking employers were taking serious thought as to the health of their personnel. And here was a business that had been but newly created, and was facing the problems that are common to all new businesses. They were tremendously preoccupied, those pioneers of the first decades of telephone history, in doing the thousand and one things that had to be done in order to make Bell's invention work satisfactorily. It would have been

small wonder if they had come to the conclusion that, with a multitude of seemingly more important things crying out for attention, they had scant time to think of the health of their employees.

And yet the evidence is clear that these men who, in those busy pioneering days, laid the foundations of the Bell System, laid also the foundation for what might be called the Bell System's philosophy or unwritten policy regarding the provision of wholesome working conditions for its employees, and for its present activities which are directed toward helping the employees to take an intelligent interest in their own health. This philosophy, and the means for its practical application, did not come into existence full-grown. They have been the results of a long process of evolution, as has every other useful thing in the telephone business. Yet the initial steps in this evolution were taken in those first telephone years, more than half a century ago.

Few men are more familiar with the fundamentals of this philosophy than Dr. C. H. Watson and Charles J. Schaefer, Jr., of the Benefit and Medical Department, American Telephone and Telegraph Company. On this subject both men speak with authority, Dr. Watson primarily from the standpoint of the medical man and Mr. Schaefer from that of one who has had wide experience in solving the administrative problems arising from the application of this policy to the requirements of the widely separated territories of the Bell System as a whole.

Inseparable Obligations

"It is a significant fact," Dr. Watson began, "that the development of telephone service, at its very inception, fell into the hands of men who had not only high ideals as to the obligation to the public which the provision of such a service carried with it, but who clearly saw that this obligation was inseparable from the responsibility of taking a personal interest in the welfare of their employees.

"This interest was, I think, originally only what that word implies. It was probably not even a definitely formed point of view. Rather, these telephone pioneers took an unconscious interest in their employees because it was natural for them to do so—they were that kind of men. Precedent crystallized this interest into a point of view, and the point of view, in turn, into a generally accepted philosophy. By a process of evolution, this philosophy eventually became a definite part of the Bell System's fundamental policy of providing for the public 'the most telephone service and the best.'

"In our health activities our interest is directed, as it should be, primarily toward the welfare of our employees. Secondarily it is directed toward the public, and the kind of service we provide for that public. In a very true sense, the welfare of employees and the quality of service are directly related. Put an operator, with a number of other operators, into a room that is inadequately lighted or improperly ventilated and heated, and see what would happen to your service. Or try giving the type of service we give now, without the provision of wholesome and attractive rest and recreation rooms or places in which the operators may have their meals. Or discard what we are doing along the line of giving medical advice or assistance when required. Or abandon our health education activities. You will find that our philosophy as to the physical wellbeing of our employees is definitely a part of our policy of providing the best possible service."

An Operating Room in 1883

The progress made in the practical application of the Bell System's philosophy as to the welfare of its employees—and particularly of its operators—may, perhaps, best be shown by contrasting conditions in the typical operating room of a modern central office with those in equally typical central offices of a half a century ago. Here, for example, is a bit of description

from the pen of Miss Frances Oberbeck, who tells of the office in which she went to work as an operator in St. Louis in 1883:

The office was located on the second floor of a three-story brick building which had been built for a store. The Telephone Company floor was divided into three rooms. The front room, which was the largest, was the operating room. It was heated by an old iron stove and lighted by a bracket of coal oil lamps suspended from the switchboard. This old stove was one which invariably needed cleaning on the coldest days of winter. Our chief operator would rake out the hot coals on a big sheet of tin, open wide all the windows so as to blow out the smoke, and clean the stove while we poor operators sat shivering at the switchboard, trying to establish connections.

The middle room was the rest room. There was no ventilation except what came through from the operating room, and it was poorly lighted by a coal oil lamp suspended from the ceiling. The furnishings were most scanty. There was a long table where we ate our lunch, which we carried to work with us, a few chairs and a row of hooks upon which we hung our hats and coats.

In Massachusetts, where the telephone was born and where, presumably, its development had gone farther, the physical conditions under which the operators worked were hardly less primitive. Miss Grace G. Hollis writes of an office in Somerville, as it was in 1885, in these words:

The office at that time was located in a wooden building over a drug store. The company quarters included an operating room, a small office for the superintendent, and a stock room in the corner in which a wash room was located. Gas was used for lighting the rooms and a parlor stove provided heat. The night operator brought in enough wood and coal to keep the fire during the day, but in real cold weather the girls carried additional coal when necessary. The floors were uncovered and all washing, cleaning and general janitor work was done by the operators.

When Lunch Time Came

Another contrast, hardly less striking and significant, may be afforded by comparing a modern telephone company lunch room with the facilities, or the lack of them, with which the operators of pioneer days seem to have philosophically con-

tented themselves. Miss Augusta Greenslade, who began work as an operator in New York in 1892, gives this graphic description of some of the disadvantages which attended the lunch hour in her particular office:

On my first day when I went to lunch I found that the mice had eaten half of what I had brought from home. Being young and always ready to eat, and not having money to buy another lunch, I finished what the mice had left. Thereafter I carried my lunch in a tin box. It was not considered dignified to carry your lunch, so I carried my tin box in a black satin bag.

An Evolution Under Way

Even at the time when conditions like this continued to exist in some places, there is evidence that the evolution toward present-day health policies was under way in others. Here and there a few central office managers began the practice of providing for the services of a matron, who came in each day to prepare tea, coffee or hot water, or to lend a helpful hand to any operator who might be ill. In certain offices, in the Eighties and Nineties, it was the custom to supply free coffee, cocoa, bread, butter and fruit for the operators' lunches. A lunch-room based on the cafeteria principle was opened as early as 1895. By about the end of the first decade of the present century, most of the companies were providing dining service in their principal cities. From this point on, the development of the attractive, comfortable and carefully supervised dining room in the typical telephone office of the present day has been a process of gradual but steady growth.

A similar process of growth from small beginnings has taken place with regard to the provision of medical facilities by the Bell System companies for their employees. A most elementary form of providing medical treatment was that which some managers adopted, apparently at an early period of telephone history. In cases of illness or minor accident, a boy was dispatched to the nearest drug store, with a modest sum provided out of company funds, to buy such medicines or simple drugs

as a layman's diagnosis seemed to indicate were required to meet the situation.

Another step forward was the emergency cabinet with which all but the smallest central offices were later provided. These were kept supplied with a moderate assortment of simple remedies for minor illnesses.

If an operator was more seriously ill, she was sent home and advised to consult her family physician, or a doctor was summoned. Here, incidentally, is one of the fundamentals of the Bell System's health policy, as Dr. Watson specifically points out.

Not Substitute for Private Physician

"Our medical work," says he, "never was and is not now intended to take the place of the services of the employee's private physician. Sometimes our work is quite simple in its nature, as it was everywhere in the early days, and as it has to be in some localities even today. Sometimes it is more extensive, as it is in many of our Associated Company headquarters buildings, where we have many hundreds of employees. In either case, our medical activity goes no further in the direction of treatment than the provision of relatively simple remedies in emergency cases, where the services of a family physician are not required, or of rendering temporary treatment to tide a patient over until his or her physician can be consulted. One of the most important services we perform lies in the direction of diagnosis and advice, in which we are often able to coöperate closely with the employee's private physician.

"Our medical work has, of course, made another important contribution to the welfare of the employees. I refer to the physical examinations which prospective employees are given when applying for positions. These are important, not alone from the standpoint of keeping the physical condition of our personnel up to a high standard, but for the purpose of enabling

us to place each new employee in the position for which he or she is best fitted, mentally and physically, and in which, therefore, he or she can best take advantage of the opportunities for advancement afforded in telephone work.

"In short, our medical activities are directed toward the objective of getting employees who are fitted for the work to which they are assigned, and helping to keep them fit, mentally and physically, to do that work as well as it can be done. That is our part of the job of giving the public the best possible telephone service the Bell System can provide."

An important step in the development of the Bell System's health policy was the establishment, in 1913, of the Employees' Benefit Plan, by means of which, in addition to other classes of benefits and pensions, provision is made for the financial care of employees during illness, through a continuation, for specified periods, of full pay and half pay. This plan was likewise the result of a process of evolution. Quite early in telephone history, practices were followed in certain places which provided some financial aid to employees during illness. However, such practices, where they were in effect, differed with respect to amounts and periods of payments in the various Associated Companies. With the adoption of the Employees Benefit Plan, this financial care of employees during illness and certain other emergencies became systematic and was placed on a uniform basis throughout the Bell System. In the administration of this plan, the medical activities of the American Telephone and Telegraph Company and the Associated Companies play an important part.

"An Ounce of Prevention"

It has been said, so many times that the expression has become a household adage, that "an ounce of prevention is worth a pound of cure." This principle forms an inherent and essential part of the Bell System's policy as to the health of its employees. Like other phases of telephone development, this

preventive health work has been a growth from small beginnings. In many cities the principle of "an ounce of prevention" was put into practical effect many years ago by managers who made it a practice to keep on hand in each central office a supply of dry stockings and slippers to be used by operators who came to work with wet feet. Rubbers and umbrellas were also supplied for the use of those who were faced with the problem of getting home through an unexpected shower. Now, in all but the smaller places, each operator has an individual locker, in which she can keep her own supply of such articles.

One of the most practical forms of preventing disease and illness due to accident is education. Largely out of the Bell System's educational work in accident prevention and first aid training, at first confined to its male employees, has grown another branch of instruction designed particularly for women—the Health Course.

Prior to 1925 a considerable amount of experimental work in health education had been done by several Bell System Companies, including the New York Telephone Company and the Bell Telephone Company of Pennsylvania. Mr. Schaefer participated in the development of the health courses given to its women employees by the latter company. In 1925 he was transferred to the American Telephone and Telegraph Company, at the suggestion of the late Edward K. Hall, then Vice President in charge of personnel matters, and asked to assist in organizing a health course for women throughout the Bell System. He has been engaged since then in this and the other phases of the work of the Benefit and Medical Department of the American Company, and speaks out of wide experience.

Facts, Not Fads or Fancies

"Advice on health," says Mr. Schaefer, in commenting on the fundamental reasons for the establishment of the course, "is one of the easiest things in the world to obtain. The trouble is that the advice which one receives is sometimes so heavily

tinctured with theory or with outright mistakes or misstatements that it is untrustworthy. To follow it may prove positively harmful.

"At the time this course was established, there was, as there still is, a definite demand on the part of telephone women for health information in which they could have absolute confidence. They wanted facts separated from fads and fancies. Our course was designed to meet this demand. It provided instruction in emergency care of minor illnesses and injuries, the principles of hygiene and the elements of the care of the sick in the home. We were not and we are not now trying to turn out the equivalent of professional nurses, so far as the care of the sick is concerned. It is merely intended, with respect to this part of the course, to fit telephone women to do the simple home nursing, which under any conditions many of them may be called upon to do at some time or other, a little more capably than they could do it without this training."

The Health Course Grows

During its first year, more than 17,000 telephone women were enrolled in the Health Course, of whom more than 14,000 were graduated. In the second year, more than 45,000 were enrolled, of whom more than seventy-four per cent completed the course. Since the course was established, more than 149,000 women have been graduated. Of these, many have continued their studies by taking advanced courses in first aid treatment and nutrition, the graduates of the latter course now numbering more than 7,000.

"In the preparation and development of the Health Course, and of all of our health activities," says Mr. Schaefer, "we have had the valuable advice and active participation of our associates in the operating departments here at headquarters and in the Associated Companies. I am sure that Dr. L. D. Bristol, our Health Director, who is now in charge of health educational work, recognizes, as we have in the past, the im-

portant assistance given us by these representatives of other departments. I am certain, too, that he will agree with me that a tribute is due to the women of all ranks of the organization who have participated so wholeheartedly in the work, and made so many sound suggestions for its improvement."

Among the multitude of changes brought by the passing years, few have contributed more importantly to the improvement of telephone service than those which have had to do with the health of employees. This has been particularly true as applied to the women at the switchboard. The gradual growth of the Bell System's interest in the health of its employees and the evolution of means for the practical application of this interest have been integral parts of the evolution of telephone service itself—steps in the steady advance toward the objective of the best telephone service that it is humanly possible to provide, at the lowest possible cost.

R. T. BARRETT

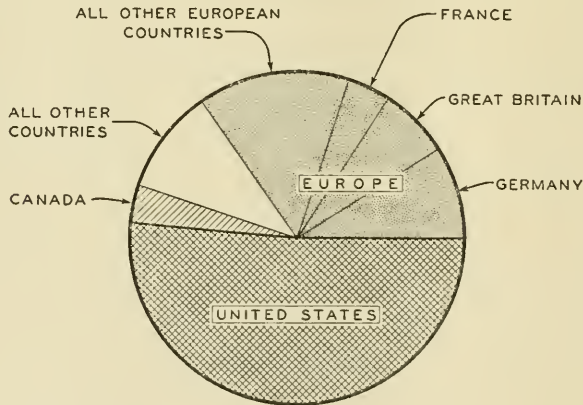
(To be concluded)

The World's Telephone Statistics

January 1, 1934

AS the years go by, the telephone becomes more and more firmly established as an invaluable instrumentality of economic and social welfare. Although telephone facilities are much more extensive in the United States than elsewhere, the annual surveys of telephone growth and development throughout the world undertaken by the Chief Statistician of the American Telephone and Telegraph Company show an unmistakable trend towards greater telephone usage in every country. The results of the latest survey have recently been published in a pamphlet entitled "Telephone and Telegraph Statistics of the World, January 1, 1934." The figures and charts in this article have been taken from that pamphlet.

DISTRIBUTION OF THE WORLD'S TELEPHONES
January 1, 1934



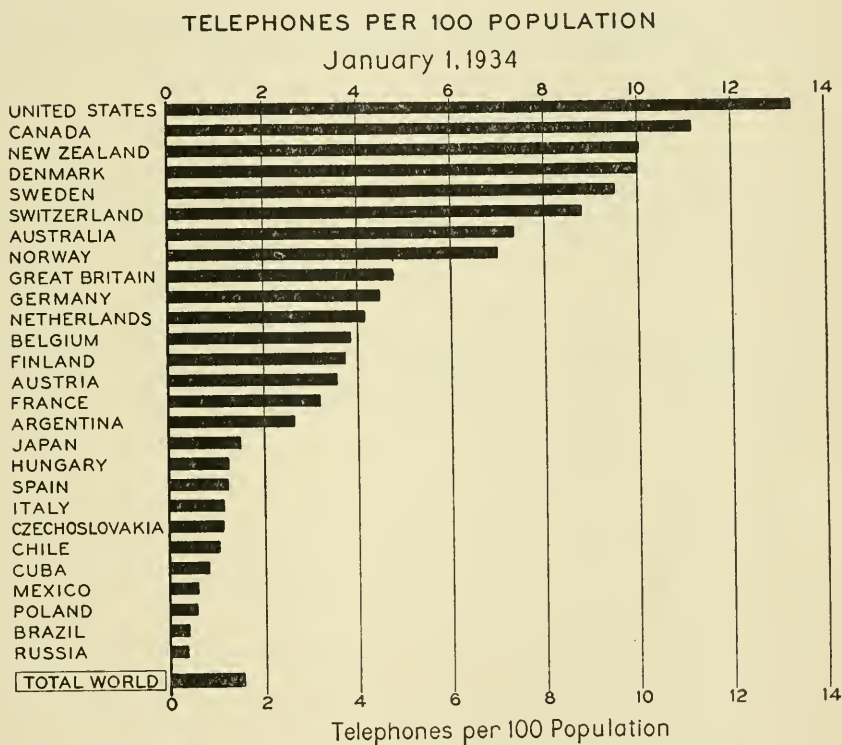
There were 32,495,855 telephones in the world on January 1, 1934. Of these, 16,710,858, or 51.4 per cent, were in the United States. This number was almost 50 per cent greater

THE WORLD'S TELEPHONE STATISTICS

than the number of telephones (11,306,955) in all of Europe, although Europe has a population four and a half times that of this country. The remaining 4,478,042 telephones were distributed among the countries outside the United States and Europe.

COMPARATIVE TELEPHONE DEVELOPMENT OF COUNTRIES

The table, "Telephone Development of the World, by Coun-



tries," presents data for individual countries of the world in respect of telephone density, conventionally measured by the number of telephones in relation to each 100 of the population. The supremacy of the United States in point of telephone development remains undisputed, this country having 13.29 telephones per 100 population. The Dominion of

TELEPHONE DEVELOPMENT OF THE WORLD, BY COUNTRIES January 1, 1934

Countries	Number of Telephones		Percent of Total World	Telephones Per 100 Population
	Government Systems	Private Companies		
NORTH AMERICA:				
United States.....	—	16,710,858	51.42%	13.29
Canada.....	193,641	998,689	3.67%	11.15
Central America.....	12,137	14,020	.08%	0.39
Mexico.....	1,337	99,871	.31%	0.59
West Indies:				
Cuba.....	485	32,355	.10%	0.81
Porto Rico.....	537	11,209	.04%	0.71
Other W. I. Places.....	7,044	14,135	.07%	0.32
Other No. Am. Places.....	—	11,032	.03%	3.02
Total.....	215,181	17,892,169	55.72%	10.38
EUROPE:				
Austria.....	239,870	—	.74%	3.55
Belgium**.....	317,217	—	.98%	3.86
Bulgaria.....	20,276	—	.06%	0.33
Czechoslovakia.....	149,296	19,878	.52%	1.12
Denmark#.....	16,289	348,438	1.12%	9.99
Finland.....	1,658	138,000	.43%	3.74
France.....	1,349,520	—	4.15%	3.19
Germany#.....	2,953,614	—	9.09%	4.48
Great Britain and No. Ireland.....	2,226,329	—	6.85%	4.78
Greece.....	—	20,356	.06%	0.31
Hungary.....	110,430	727	.34%	1.25
Irish Free State#.....	33,450	—	.10%	1.11
Italy*.....	—	482,507	1.48%	1.13
Jugo-Slavia.....	46,006	1,209	.15%	0.33
Latvia#.....	62,174	—	.19%	3.19
Netherlands.....	343,177	—	1.06%	4.14
Norway*.....	121,376	78,400	.61%	7.00
Poland.....	100,839	88,366	.58%	0.57
Portugal.....	11,500	35,706	.15%	0.68
Roumania.....	—	51,613	.16%	0.28
Russia†.....	576,332	—	1.77%	0.35
Spain.....	—	290,829	.90%	1.24
Sweden.....	589,394	1,520	1.82%	9.51
Switzerland.....	363,655	—	1.12%	8.81
Other Places in Europe.....	104,308	12,696	.36%	1.41
Total.....	9,736,710	1,570,245	34.79%	2.02

SOUTH AMERICA:

Argentina.....	—	312,086	312,086	.96%	2.64
Bolivia.....	—	2,000	2,000	.01%	0.06
Brazil.....	1,041	169,764	170,805	.53%	0.38
Chile.....	—	46,159	46,159	.14%	1.04
Colombia.....	2,500	27,425	29,925	.09%	0.32
Ecuador.....	3,010	2,730	5,740	.02%	0.23
Paraguay.....	—	2,499	2,499	.01%	0.28
Peru.....	—	17,200	17,200	.05%	0.27
Uruguay.....	—	42,707	42,707	.13%	2.14
Venezuela.....	600	19,390	19,990	.06%	0.61
Other So. Am. Places.....	2,808	—	2,808	.01%	0.52
Total.....	9,959	641,960	651,919	2.01%	0.71

ASIA:

British India#.....	22,804	35,437	58,241	.18%	0.02
China.....	72,000	82,000	154,000	.47%	0.03
Japan#.....	1,015,372	—	1,015,372	3.13%	1.50
Other Places in Asia.....	132,669	60,257	192,926	.59%	0.12
Total.....	1,242,845	177,694	1,420,539	4.37%	0.14

AFRICA:

Egypt.....	46,888	—	46,888	.15%	0.22
Union of South Africa#.....	126,608	—	126,608	.39%	1.50
Other Places in Africa.....	96,317	1,813	98,130	.30%	0.09
Total.....	269,813	1,813	271,626	.84%	0.18

OCEANIA:

Australia*.....	487,662	—	487,662	1.50%	7.35
Dutch East Indies.....	38,267	3,663	41,930	.13%	0.06
Hawaii.....	—	23,111	23,111	.07%	5.78
New Zealand#.....	155,059	—	155,059	.48%	10.01
Philippine Islands.....	6,000	20,182	26,182	.08%	0.19
Other Places in Oceania.....	3,294	228	3,522	.01%	0.15
Total.....	690,282	47,184	737,466	2.27%	0.81
TOTAL WORLD.....	12,164,790	20,331,065	32,495,855\$	100.00%	1.54

* June 30, 1933.

** February 28, 1934.

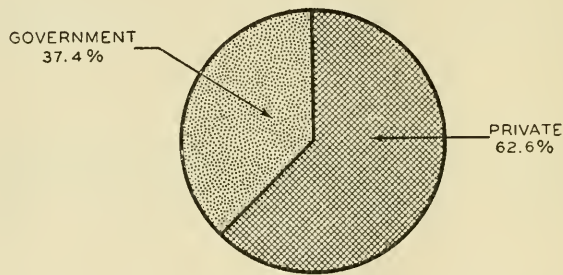
March 31, 1934.

† U.S.S.R., including Siberia and Associated Republics.

§ Includes approximately 14,300,000 automatic or "Dial" telephones, of which about 46% are in the United States.

Canada continues in second position with 11.15, New Zealand is third (10.01), Denmark fourth (9.99), and Sweden fifth (9.51). In regard to the major European countries, Great Britain, with a development of 4.78, ranks tenth; Germany, which has 2,953,614 telephones and is second to the United States in absolute number of instruments, ranks eleventh as regards telephones per 100 population (4.48); while France ranks sixteenth, with 3.19. Japan, with a little over one million telephones, is the outstanding telephone country in Asia, although its development of only one and one-half telephones for each 100 of its people is well below that of the larger Occidental

OWNERSHIP OF THE WORLD'S TELEPHONES
January 1, 1934



countries. Argentina, with a telephone development of 2.64, leads all other South American countries.

Of the total number of telephones in the world, 62.6 per cent are in systems which are owned and operated by private companies. The achievement of the private companies in the United States, the best developed country in the world telephonically, is well known. In Canada, the next best developed country, 84 per cent of the telephones are under private ownership and management. Denmark ranks fourth in respect of telephone development and over 95 per cent of its telephones are owned and operated by private companies. In striking contrast to these countries are the three major European nations, Great Britain, Germany, and France, where the tele-

TELEPHONE DEVELOPMENT OF LARGE AND SMALL COMMUNITIES January 1, 1934

Country	Service Operated by (See Note)	Number of Telephones		Telephones per 100 Population	
		In Communities of 50,000 Population and Over	In Communities of less than 50,000 Population	In Communities of 50,000 Population and Over	In Communities of less than 50,000 Population
Australia*	G.	279,700	207,962	8.71	6.08
Austria	G.	178,802	61,068	8.13	1.34
Belgium**	G.	221,621	95,596	6.33	2.03
Canada	P. G.	647,000	545,330	19.33	7.43
Czechoslovakia	P. G.	69,133	100,041	4.04	0.75
Denmark	P.	181,822	180,778	19.24	6.72
Finland†	P.	50,151	84,500	10.49	2.61
France	G.	734,401	615,119	8.31	1.84
Germany#	G.	1,897,458	1,056,156	7.12	2.69
Great Britain and No. Ireland#	G.	1,618,500	646,700	6.17	3.18
Hungary	G.	84,636	26,521	4.14	0.39
Japan#	G.	656,752	358,620	3.41	0.74
Netherlands	G.	224,604	118,573	6.65	2.41
New Zealand#	G.	61,486	93,573	11.34	9.29
Norway*	P. G.	76,461	123,315	18.88	5.03
Poland	P. G.	111,102	78,103	2.29	0.28
Spain	P.	177,601	113,228	3.54	0.62
Sweden	G.	231,996	358,918	22.59	6.92
Switzerland	G.	163,961	199,694	18.82	6.13
Union of South Africa	G.	69,451	57,157	6.77	0.77
United States	P.	9,386,321	7,324,537	18.54	9.76

Note: P. indicates that the telephone service is wholly or predominantly operated by private companies, G. wholly or predominantly by the Government, and P. G. by both private companies and the Government. See first table.

* January 1, 1933.

† June 30, 1933.

** February 28, 1934.

March 31, 1934.

phone service is operated exclusively by the government and which rank tenth, eleventh, and sixteenth, respectively, as regards telephone development.

TELEPHONES IN LARGE AND SMALL COMMUNITIES

Telephone development is not only higher, but is more widely distributed, in the United States than in other countries. The table "Telephone Development of Large and Small Communities" gives some indication of this fact. It will be observed that in the smaller communities—those with less than 50,000 inhabitants—the United States averaged 9.76 telephones per 100 population. This not only exceeds the development of the smaller communities in all other countries, but reflects a considerably better telephone development of these communities in this country than the development of all but three foreign countries *as a whole*. Compared to these American standards, telephone facilities in the smaller towns and rural areas abroad are generally exceedingly limited: in Great Britain, there were only 3.18 telephones per 100 population in the smaller communities, in Germany 2.69, and in France 1.84.

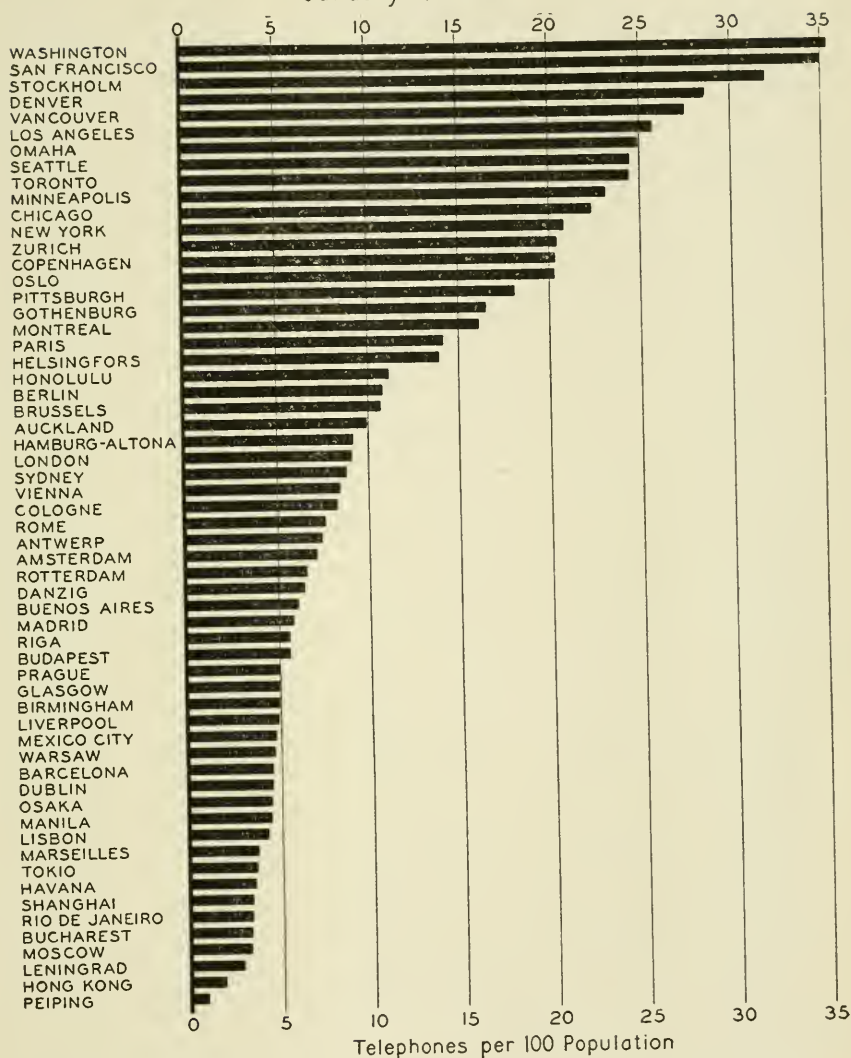
TELEPHONES IN LARGE CITIES

Among the large cities of the world, Washington, D. C., leads in respect of telephone development, with 35.31 telephones per 100 population. San Francisco is second, with a development of 35.00. As a matter of fact, except for the Swedish city of Stockholm, which has a development of 31.95, and the two Canadian cities of Vancouver (27.51) and Toronto (24.44), no large foreign city has a better telephone development than the first thirty-five ranking cities in the United States, nine of which are among the cities shown on the accompanying chart "Telephones per 100 Population of Large Cities." It is interesting to compare the telephone development of Europe's larger cities with that of the metropolitan

THE WORLD'S TELEPHONE STATISTICS

TELEPHONES PER 100 POPULATION OF LARGE CITIES

January 1, 1934



centers of the United States. Thus, New York had 20.83 telephones per 100 of its inhabitants, whereas London had only 9.07. Chicago had 22.35, against 10.85 for Berlin. Los Angeles had 25.75, while Paris had 14.18.

TELEPHONE DEVELOPMENT OF LARGE CITIES

January 1, 1934

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
ARGENTINA:			
Buenos Aires.....	2,970,000	179,154	6.03
AUSTRALIA:			
Adelaide.....	313,000	27,692	8.85
Brisbane.....	301,000	25,107	8.34
Melbourne.....	996,000	94,779	9.52
Sydney.....	1,240,000	108,679	8.77
AUSTRIA:			
Graz.....	160,000	8,019	5.01
Vienna.....	1,900,000	159,478	8.39
BELGIUM: **			
Antwerp.....	530,000	38,993	7.36
Brussels.....	966,000	103,580	10.72
Liège.....	427,000	23,001	5.39
BRAZIL:			
Rio de Janeiro.....	1,717,000	55,460	3.23
CANADA:			
Montreal.....	1,017,000	164,184	16.14
Ottawa.....	186,700	35,256	18.88
Toronto.....	757,000	184,982	24.44
Vancouver.....	189,000	51,888	27.51
CHINA:			
Canton.....	1,050,000	7,300	0.70
Hong Kong.....	850,000	14,871	1.75
Peiping.....	1,520,000	12,390	0.82
Shanghai ††.....	1,500,000	49,401	3.29
CUBA:			
Havana.....	780,000	26,801	3.44
CZECHOSLOVAKIA:			
Prague.....	910,000	45,451	4.99
DANZIG:			
Free City of Danzig.....	263,000	16,725	6.36
DENMARK:			
Copenhagen.....	813,000	165,518	20.36
FINLAND:			
Helsingfors.....	265,000	36,962	13.95
FRANCE:			
Bordeaux.....	267,000	19,551	7.32
Lille.....	202,000	16,954	8.39
Lyons.....	667,000	35,345	5.30
Marseilles.....	895,000	32,428	3.62
Paris.....	2,900,000	411,249	14.18
GERMANY: ‡			
Berlin.....	4,205,000	456,304	10.85
Breslau.....	625,000	40,192	6.42
Cologne.....	758,000	62,254	8.21
Dresden.....	726,000	58,560	8.07
Dortmund.....	582,000	22,826	3.92
Essen.....	660,000	28,748	4.35
Frankfort-on-Main.....	648,000	59,752	9.22
Hamburg-Altona.....	1,643,000	150,292	9.15
Leipzig.....	766,000	63,369	8.27
Munich.....	738,000	74,152	10.05
GREAT BRITAIN AND NO. IRELAND: ‡			
Belfast.....	415,000	17,945	4.32
Birmingham.....	1,200,000	59,248	4.94
Bristol.....	415,000	21,015	5.06
Edinburgh.....	442,000	31,873	7.21
Glasgow.....	1,190,000	58,806	4.94
Leeds.....	512,000	24,135	4.71
Liverpool.....	1,196,000	57,993	4.85
London.....	9,170,000	831,800	9.07
Manchester.....	1,100,000	64,402	5.85
Newcastle.....	470,000	19,527	4.16
Sheffield.....	518,000	19,829	3.83
HAWAII:			
Honolulu.....	138,000	15,446	11.19
HUNGARY:			
Budapest.....	1,350,000	74,743	5.54
Szeged.....	140,000	1,898	1.36
IRISH FREE STATE: ‡			
Dublin.....	424,000	18,972	4.47

TELEPHONE DEVELOPMENT OF LARGE CITIES (Concluded)

January 1, 1934

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
ITALY:			
Milan.....	1,025,000	84,956	8.29
Naples.....	1,000,000	26,135	2.61
Rome.....	1,045,000	79,247	7.58
JAPAN:†			
Kobe.....	837,000	32,482	3.88
Kyoto.....	1,027,000	40,695	3.96
Nagoya.....	990,000	33,243	3.36
Osaka.....	2,654,000	117,104	4.41
Tokio.....	5,486,000	195,225	3.56
LATVIA:‡			
Riga.....	417,000	23,134	5.55
MEXICO:†			
Mexico City.....	1,100,000	51,492	4.68
NETHERLANDS:			
Amsterdam.....	778,000	54,952	7.06
Haarlem.....	159,000	11,975	7.53
Rotterdam.....	608,000	39,677	6.53
The Hague.....	508,000	48,262	9.50
NEW ZEALAND:‡			
Auckland.....	214,000	21,262	9.94
NORWAY:*			
Oslo.....	250,000	50,763	20.31
PHILIPPINE ISLANDS:			
Manila.....	390,000	17,136	4.39
POLAND:			
Lodz.....	875,000	13,360	1.53
Warsaw.....	1,230,000	56,839	4.62
PORTUGAL:			
Lisbon.....	630,000	26,455	4.20
ROUMANIA:			
Bucharest.....	670,000	21,450	3.20
RUSSIA:			
Leningrad.....	2,800,000	76,933	2.75
Moscow.....	3,700,000	117,619	3.18
SPAIN:			
Barcelona.....	1,050,000	47,212	4.50
Madrid.....	980,000	56,558	5.77
SWEDEN:			
Göteborg.....	253,000	41,965	16.59
Malmö.....	132,000	20,329	15.40
Stockholm.....	438,000	139,933	31.95
SWITZERLAND:			
Basel.....	150,000	30,208	20.14
Berne.....	113,000	23,250	20.58
Geneva.....	146,000	26,589	18.21
Zurich.....	263,000	53,799	20.45
UNITED STATES: (See Note)			
New York.....	7,180,000	1,495,922	20.83
Chicago.....	3,575,000	799,122	22.35
Los Angeles.....	1,364,000	351,174	25.75
Pittsburgh.....	1,007,900	182,483	18.11
Total 10 cities over 1,000,000 Population.....	22,020,600	4,393,541	19.95
Milwaukee.....	754,900	132,991	17.62
San Francisco.....	681,000	238,384	35.00
Washington.....	506,300	178,761	35.31
Minneapolis.....	502,000	116,145	23.14
Total 10 cities with 500,000 to 1,000,000 Population...	6,445,300	1,289,569	20.01
Seattle.....	414,000	101,398	24.49
Denver.....	298,000	85,215	28.60
Omaha.....	236,300	58,780	24.88
Hartford.....	234,300	51,640	22.04
Total 33 cities with 200,000 to 500,000 Population....	9,832,900	1,723,484	17.53
Total 53 cities with more than 200,000 Population..	38,298,800	7,406,594	19.34

NOTE: There are shown, for purposes of comparison with cities in other countries, the total development of all cities in the United States in certain population groups, and the development of certain representative cities within each of such groups.

† January 1, 1933.

* June 30, 1933.

** February 28, 1934.

March 31, 1934.

†† International Settlement and French Concession.

The table headed "Telephone Development of Large Cities" gives further details of the development of the more important cities in the various countries of the world. Statistics are presented also for the telephone development of American cities according to various population classes, which may be summarized as follows:

	Telephones per 100 Pop.
10 cities with more than 1,000,000 population.....	19.95
10 cities with 500,000 to 1,000,000 population.....	20.01
33 cities with 200,000 to 500,000 population.....	17.53
53 cities with over 200,000 population.....	19.34
All communities with more than 50,000 population.....	18.54

These figures indicate clearly the consistently high telephone development prevailing throughout the United States. In other countries, telephone service is generally concentrated in the larger cities. London had more than 37 per cent of all the telephones in Great Britain and Northern Ireland, Berlin more than 15 per cent of the German telephones, Paris over 30 per cent of the French telephones, Stockholm more than 23 per cent of the Swedish telephones. By way of contrast, New York had less than 9 per cent of the telephones in the United States, and Chicago less than 5 per cent.

K. FICK

Notes on Recent Occurrences

DR. JEWETT HONORED BY BRITISH ENGINEERS

DR. FRANK B. JEWETT, Vice President of the American Telephone and Telegraph Company and President of the Bell Telephone Laboratories, was the recipient, on May 2, of the Faraday Medal, the highest honor bestowed by the Institution of Electrical Engineers, of London. The presentation was made at a meeting of the organization held in the British capital.

The medal was presented by Dr. W. M. Thornton, President of the Institution, and an address setting forth Dr. Jewett's contributions to the development of communication was delivered by Frank Gill. Mr. Gill was for many years an executive of the European branch of the Western Electric Company and as such was closely associated with developments in which Dr. Jewett played an important part. In outlining Dr. Jewett's career, he referred to the extension of telephone service in America until it had become continent-wide in its reach, and to the development of overseas radio telephone service. He pointed out that the Bell Telephone Laboratories, of which Dr. Jewett is the head, and Dr. Jewett himself as an individual had made outstanding contributions to these communication developments.

In a brief address of acceptance, Dr. Jewett expressed his satisfaction in the cordial relationships existing between American and British engineers and scientists in the field of electricity. He outlined some of the steps which have been taken in America toward stimulating interest on the part of graduates of scientific and engineering schools in research work in the communication field.

The Faraday Medal, established by the Institution in 1922,

is of bronze. It is awarded "for notable scientific achievement in electrical engineering, or for conspicuous services rendered to the advancement of electrical science." In awarding the medal, recipients are selected without restriction as to nationality, country of residence or membership in the Institution. Dr. Jewett is the second American who has been honored by the award. Elihu Thomson, distinguished engineer in the field of electric light and power, received the Faraday Medal in 1927. Since Dr. Thomson is of English birth, Dr. Jewett becomes the first American-born scientist to receive the award.

JAPANESE CONFER ORDER OF RISING SUN ON BELL LABORATORIES ENGINEER

THE Imperial Order of the Rising Sun was recently conferred on G. W. Gilman, of the Transmission Development Department, Bell Telephone Laboratories, by Minister of Communications Tokonami of Japan. The award was in recognition of Mr. Gilman's coöperative efforts in the preparations for radio telephone service between the United States and Japan. At the same time, Mr. Tokonami expressed his appreciation of Mrs. Gilman's assistance in these preparations.

During the year that Mr. and Mrs. Gilman spent in Japan, elaborate preparation for connecting Tokyo with various world centers by short-wave radio telephony was in progress. Mr. Gilman coöperated with the Japanese engineers in the testing of the equipment to be used on the service to the United States and in the formulation of routine testing and operating procedures to be followed upon the opening of service. He also represented the American Telephone and Telegraph Company in matters pertaining to the contractual arrangements for this service. Mrs. Gilman assisted in the training of traffic operators, instructing them in the pronunciation of names and the use of terms and expressions that are more or less standardized in the United States.

Other Bell System engineers and scientists who have been honored by the Japanese government include the late John J. Carty, who was decorated by the Emperor in 1909 with the Order of the Rising Sun and in 1912 with the Imperial Order of the Sacred Treasure of Meiji; Dr. Frank B. Jewett, who received the Order of the Rising Sun in 1923 and the Order of the Sacred Treasure in 1930; and Bancroft Gherardi, who received the Order of the Rising Sun in 1923.

TWO-WAY TELEPHONE CONVERSATION IS HELD ENTIRELY AROUND THE WORLD

THE human voice traveled around the world for a new distance and time record on April 25 when President Walter S. Gifford of the American Telephone and Telegraph Company talked over a 23,000-mile telephone and radio circuit which originated and terminated in the Long Lines building in New York City. "This is another step in the conquest of time and space by man," said Mr. Gifford to Vice-president T. G. Miller, head of the Long Lines Department, "and proves there are no earthly limits to human speech."

In this first demonstration of a two-way telephone call around the world, Mr. Gifford used the longest telephone circuit ever established. The route of the call was through San Francisco, Java, Amsterdam, London, and back to New York.

From New York Mr. Gifford's voice crossed the continent over wire through St. Louis and Los Angeles to San Francisco, and then to the Bell System's short wave transmitting station at Dixon, California. From this station Mr. Gifford's voice was transmitted 9,000 miles across the Pacific to the overseas telephone terminal of the Netherlands Telephone Administration at Bandoeng, Java. Here it was transferred to another short wave radio telephone circuit spanning the distance of 7,000 miles to Amsterdam. By submarine cable beneath the North Sea the voice path led over wires and cables to the Lon-

don trunk exchange and thence to the Rugby radio station of the British Post Office. At Rugby the voice impulses were again sent out by short wave radio and were received at the American Telephone and Telegraph Company station at Netcong, New Jersey. The remainder of the route was over telephone cable.

Mr. Miller's answering voice sped in the opposite direction. At Lawrenceville, New Jersey, it was put on the air to be received at Baldock, England. Thence it went by wire through London to Amsterdam, where a short wave radio telephone station once more sped the voice impulses through the ether to Java. Thence the final radio stage was to California, and by wire and cable back to New York.

The circuit linking the two telephones, which were actually within fifty feet of each other, was more than 23,000 miles long. The voice impulses covered this distance in a quarter of a second. Following his informal conversation with Mr. Miller, Mr. Gifford called the roll of the various points through which the circuit passed, speaking in turn with the telephone engineers at San Francisco, Java, Amsterdam and London.

BELL TELEPHONE QUARTERLY



VOL. XIV

OCTOBER, 1935

NO. 4

MODERN BUSINESS ADOPTS THE
TELETYPEWRITER

ANSWERING STOCKHOLDERS' LETTERS
BY TELEPHONE

TWENTY YEARS OF TRANSCONTINENTAL
SERVICE

THE CHANGING YEARS AS SEEN FROM
THE SWITCHBOARD

CHANGES IN BIRTH AND DEATH RATES
AS AFFECTING POPULATION GROWTH

BELL TELEPHONE QUARTERLY

*A Medium of Suggestion
and a Record of Progress*

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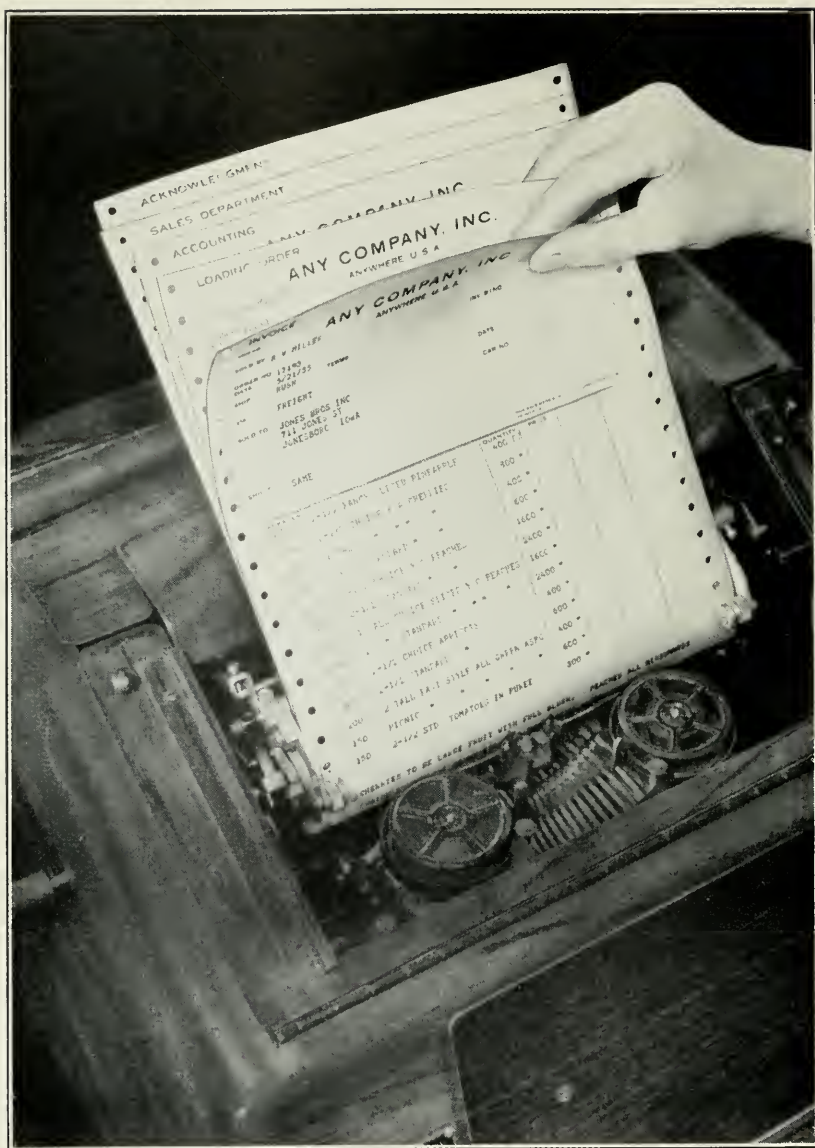
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THE SIMULTANEOUS PRODUCTION OF MULTIPLE COPIES OF BUSINESS FORMS ON TWO OR MORE CONNECTED TELETYPEWRITERS, NO MATTER HOW FAR APART, IS A USEFUL FEATURE OF BELL SYSTEM TELETYPEWRITER SERVICE. HOW THIS INSTANTANEOUS "FORM WRITING" AT A DISTANCE AIDS MODERN BUSINESS IS TOLD IN THE ARTICLE WHICH BEGINS ON THE OPPOSITE PAGE.

Modern Business Adopts the Teletypewriter

AT the beginning of the year 1935, there were throughout the country more than 12,000 teletypewriters connected to the Bell System. The widespread adoption by industry of the "typing by wire" method of communication is proof of its value to modern American business. Instantaneous two-way communication and a printed record of every transaction are fundamental advantages which the service has always offered and which have been generally recognized for a long time.

In the last half century economic necessity has dictated the geographical separation of industrial units. If national markets are to be reached and production costs held within reasonable limits, there must be sales representation at distribution centers and factories close to raw materials. Moreover, the activities of these units have to be closely coördinated. Long before the advent of the teletypewriter, industry was exercising control over distant offices principally by mail, message telephone and telegraph services and by private wires, either telephone or Morse.

It was natural, therefore, that the exclusive advantages of teletypewriter service should cause it to be adopted for similar purposes by many industrial companies soon after it was offered commercially. At that time the service was available only on a private line basis and was used generally by the larger concerns.

In recent years, however, the scope of teletypewriter service has been so broadened that it is now within the reach of practically any company. In addition, it has been successfully applied to fundamental business practices in ways which were not dreamed of a few years ago. All this has been made pos-

BELL TELEPHONE QUARTERLY

ORDER-WRITING TELETYPEWRITER SERVICE NEW YORK - BUFFALO - CLEVELAND - DETROIT

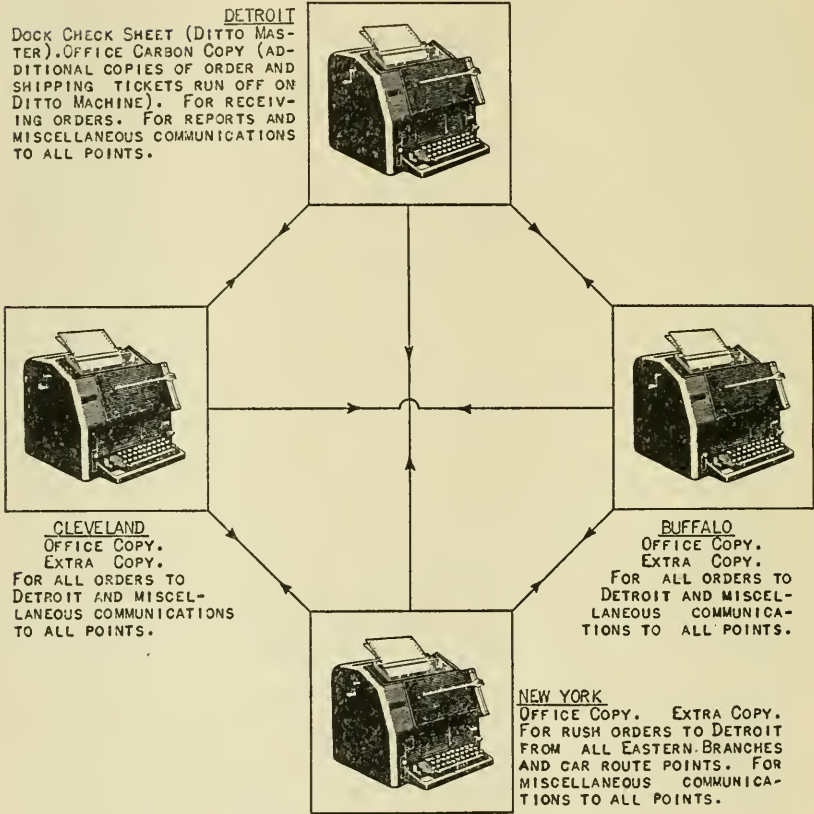


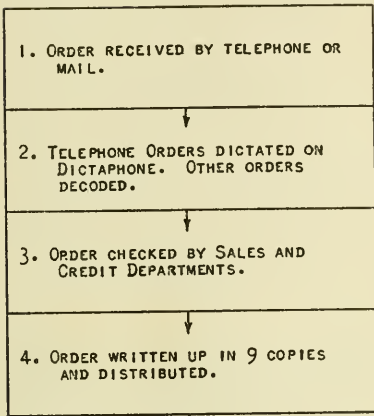
FIG. 1. THIS DIAGRAM REPRESENTS A PRIVATE-LINE TELETYPEWRITER ORDER-WRITING SYSTEM WHICH PERMITS A REVISION OF FORMER ORDER-WRITING METHODS, IMPROVES SERVICE TO CUSTOMERS, AND ENABLES THE COMPANY ADOPTING IT TO COMPETE WITH OTHER COMPANIES IN EASTERN MARKETS ON AN EQUAL BASIS. FIGURES 2, 3 AND 4 ILLUSTRATE GRAPHICALLY THE IMPROVEMENTS IN THE TECHNIQUE OF HANDLING ORDERS AND THE ELIMINATION OF STEPS PREVIOUSLY REQUIRED TO HANDLE THE SAME WORK, AT A SAVING OF TIME AND COST.

MODERN BUSINESS ADOPTS TELETYPEWRITER

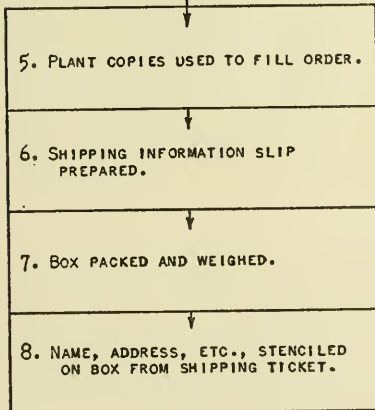
CHANGES IN ORDER ROUTINE AT DETROIT
ON ORDERS FROM CLEVELAND, BUFFALO
AND ALL EASTERN POINTS

OLD METHOD

OFFICE

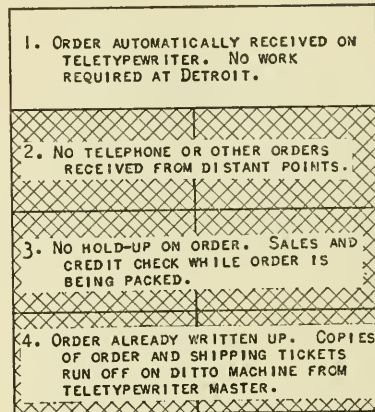


PLANT

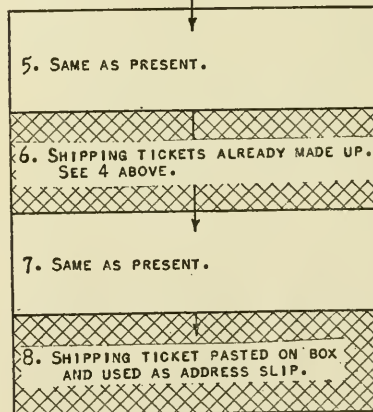


NEW METHOD

OFFICE



PLANT



 THIS WORK ELIMINATED UNDER NEW METHOD.

FIGURE 2.

BELL TELEPHONE QUARTERLY

sible by mechanical improvements and the invention of special equipment, the results of continuous laboratory experiment over a long period. Exhaustive investigations of the requirements of business have played an important part in these advances.

CHANGES IN ORDER ROUTINE AT CLEVELAND AND DETROIT ON ORDERS FROM CLEVELAND

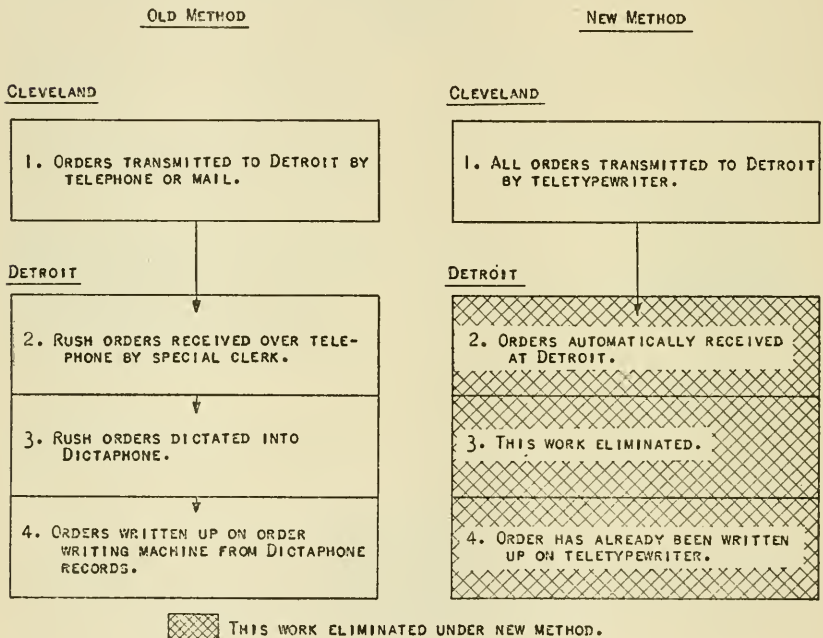


FIGURE 3.

The introduction of Teletypewriter Exchange Service late in 1931 resulted in a more general acceptance by industry of the teletypewriter as an efficient and business-like communication medium. The new service can be used for periods as short as three minutes. Connections are obtained on demand, whereas private line facilities are furnished by pre-arrangement. Moreover, any subscriber can be connected through

MODERN BUSINESS ADOPTS TELETYPEWRITER

CHANGES IN ROUTINE ON ORDERS FROM BUFFALO

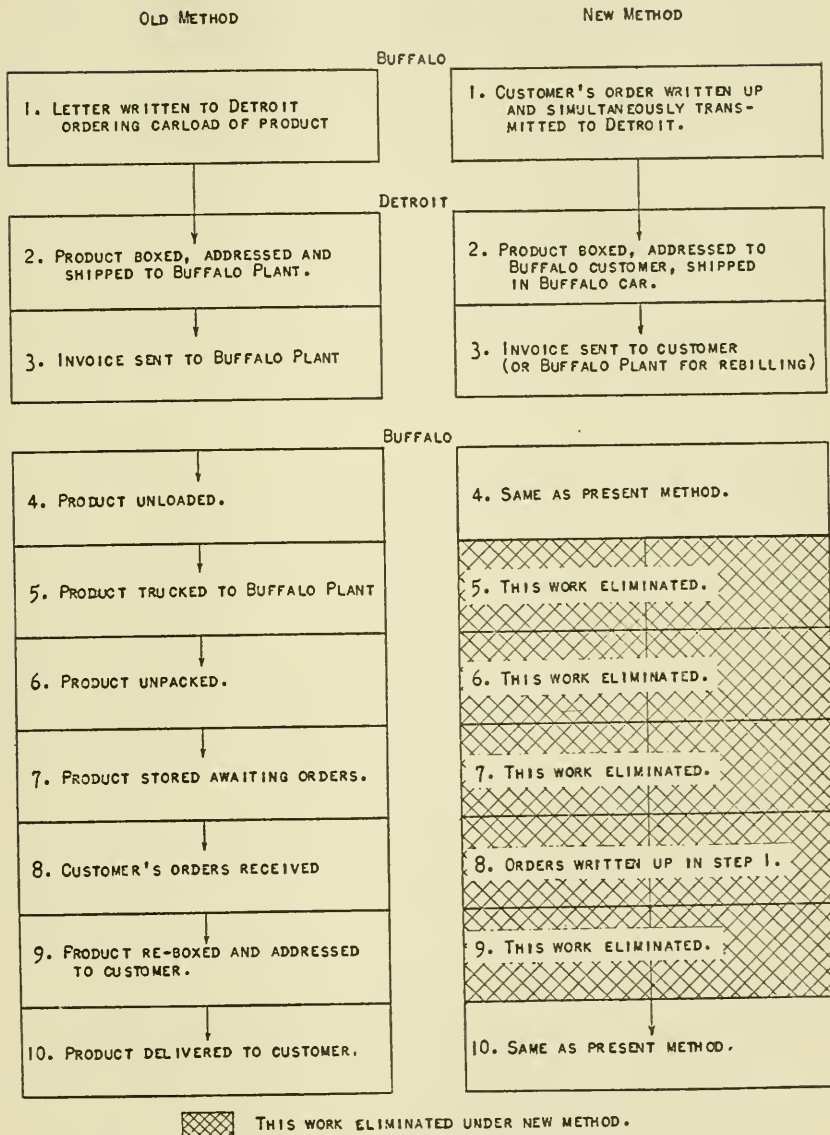


FIGURE 4.

Bell System exchanges to any other subscriber. Since 1931, Teletypewriter Exchange Service has had a steady growth, more than 200 kinds of business being represented by its users. Approximately 7500 stations scattered from coast to coast now serve more than 3000 different organizations.

While successful business operation depends in large measure upon adequate wire communication facilities allowing intimate supervision of distant units, there has to be some way of recording the details of transactions which are handled by wire. There must be office systems and equipment for the maintenance and distribution of the paper records and forms essential to modern management. Where teletypewriter service is used, practically all of these requirements are now met through the automatic reproduction of identical communications at connected points.

Business practice frequently necessitates the use of complicated forms for recording and transmitting, from one point to another, customers' orders, production reports, purchase requisitions or other matters. Several copies have to be furnished for departments performing specialized functions. While teletypewriter service was still comparatively novel in the industrial field, it was seen that, if the service could be used for "form-writing" between distant points, office routines would be greatly simplified. Experiments along these lines met with little success because it was virtually impossible to insure alignment of sheets and carbons on the connected machines. In 1928, however, a sprocket feed device was perfected which made possible the alignment of paper on two or more connected teletypewriters, no matter how far apart. The new equipment also prevented slippage of copies and carbons.

This sprocket feed feature provided additional opportunities for business to capitalize on Teletypewriter Service. It became necessary to view the service not merely as a communication link between distant offices, but also as a business tool capable of performing functions which heretofore had required

the use of many different types of office equipment. The teletypewriter could perform several of these functions more efficiently and at more than one point simultaneously. The development of Teletypewriter Exchange Service has considerably widened the possibilities for commercial application of "form writing."

The mere fact that the teletypewriter could now transfer information from one printed form to another at a distance, while making several copies in the process, did not at first appear particularly significant. Experience soon indicated, however, that this feature alone permitted rearrangements of the user's fundamental practices to such an extent that large savings in overhead were made possible. In most instances, these savings have been sufficient to more than offset the cost of the Teletypewriter Service.

Bell System representatives who coöperate with business concerns to determine how their existing communication methods can be improved now have to acquaint themselves with much that formerly was not thought pertinent to the communication study. Among many other things, the routine of office procedure must be thoroughly investigated. Experience in developing the service on this basis has shown that several outstanding advantages can usually be offered.

The major advantages, not all of which are easy to evaluate but of great importance to the user, are improved delivery speed on customers' orders, reduction in inventories, the elimination of office, manufacturing and shipping peaks, and savings brought about through the faster handling of billing and collections.

Improvements in office practice which result can generally be determined in dollars and cents. It is possible to eliminate re-writing operations at one or more offices, thus permitting the re-allocation of clerical personnel. Re-copying errors, sometimes very expensive, are eliminated simply because there is no re-copying. One typing provides identical copies in sufficient

BELL TELEPHONE QUARTERLY

Buffalo—Canton		14
Buffalo, N. Y.—Continued		
Hecker-Jones Jewell Milling Co	503 Seneca	BUF 142
Hedger W C Trans Corp canal & lake trans	Chamber of Commerce bldg	BUF 60
Herrick Heinzelmann & Ripley Inc inv sec	17 Court	BUF 33
Hugenschmidt R A 174 Depew av	.....	BUF 153
Ingersoll Rand Co Eliott sq	.....	BUF 65
Kellogg Spencer & Sons vtgbl oils	58 Delaware av	BUF 50
Manufacturers & Traders Trust Co	municipal bonds 284 Main	BUF 151
Minnesota Atlantic Transit Co	275 Hamburg Turnpike	BUF 74
N Y State of Dept of Agriculture & Markets	State Office bldg	BUF 43
N Y Telephone Co Teletypewriter Training Bu-	65 Franklin	BUF 9101
Nicholson Universal SS Co	275 Hamburg Turnpike	BUF 95
O'Brian Potter & Co inva	Liberty Bank bldg	BUF 176
Dwens Illinois Glass Co glass containers	Mainine Trust bldg	BUF 162
Park & Pollard Co pltry feeds gr	856 Hertel av	BUF 129
Philadelphia & Reading Coal & Iron Co	Marine Trust bldg	BUF 55
Pillsbury Flour Mills Co LaSalette bldg	.....	BUF 139
Remington Rand Inc 465 Washington	.....	BUF 169
Schoellkopf Mutton & Pomeroy inv sec	70 Niagara	BUF 120
Seaboard Great Lakes Corp 441 Ohio	.....	BUF 64
Seaman Paper Co Vars bldg	.....	BUF 141
Seligman J & W & Co bkrs & inv bkrs	Liberty Bank bldg	BUF 161
Socony-Vacuum Oil Co Inc Buffalo Div	Genesee bldg	BUF 149
Swift & Co 85 E Market	.....	BUF 147
Trucon Steel Co 775 Main	.....	BUF 73
U S Rubber Reclaiming Co 726 Babcock	.....	BUF 126
Vietor, Common & Co inv sec	Marine Trust bldg	BUF 124
W B E N radio sta Hotel Statler	.....	BUF 22
W K B W radio sta Rand bldg	.....	BUF 23
Wallace & Trost inv sec Liberty Bank bldg	.....	BUF 52
Washburn Crosby Co Inc Roue	Marine Trust bldg	BUF 44
Worthington Pump & Machy Corp	Clinton & Roberts	BUF 159
Burbank, Cal.		
California Growers Wineries Inc	72 S Alameda	BURBANK CAL 15
K E L W radio sta	3702 Magnolia blvd	BURBANK CAL 12
Pacific Aircraft Sales Co	2627 N Hollywood way	BURBANK CAL 16
United Air Lines Transport Corp	2827 N Hollywood way	BURBANK CAL 14
Burlington, Ia.		
Hanna W D & Co invs	Main & Jefferson	BURL IA 1
Burlington, N. J.		
Devlin Thos Mig Co malleable fittings	Pearl & Reed	BURL N J 497
Burlington, N. C.		
Armco Finishing Corp cfe Elmira	BURL N C 82	
Barnwell Bros Inc trans Hawkins	BURL N C 80	
Burlington Mills crepe Elmira	BURL N C 84	
Burlington Mills Dyeing & Finishing Co	BURL N C 11	
May Hosiery Mills Inc S Maio	BURL N C 12	
Burlington, Vt.		
Lyman Elias Coal Co 206 College	BURL VT 15	
Burns, Ore.		
Hines Edward L Lumber Co	BURNS ORE 11	
Butte, Mont.		
Daniels Auto Freight Depot 226 E Broadway	BTE 14	
Federal Bur of Investigation	U S Dept of Justice Federal bldg	BTE 10
K G I R radio sta 121 W Broadway	BTE 6	
Piper Jaffray & Hopwood Co Park & Main	BTE 12	
Texas Co 47 N Main	BTE 9	
Buzzards Bay, Mass.		
Maritime Assn of Boston C of C	Bourne BUZZARDS BAY MASS 495	
Caldwell, Ida.		
Idaho Egg Producers 523 Main	CALDWELL IDA 4	
Calexico, Cal.		
Russell Bros Co auto eqpmnt	101 2nd CALEXICO CAL 13	
Calpine, Cal.		
Davies-Johnson Lumber Co	CALPINE CAL 12	
Cambridge, Md.		
Phillips Packing Co Inc food prodts	35 Race CAMB MD 382	
Phillips Sales Co Inc food prodts	33 Race CAMB MD 382	
Cambridge, Mass.		
See Boston, Mass.		
Camden, N. J.		
Evans John R & Co 2nd & Erie	CAMDEN N J 499	
Hanauer J B & Co inv sec	130 N Broadway CAMDEN N J 495	
Campbell, Cal.		
Haven Semaira Canning Co	Hopkins & Harrison CAMPBELL CAL 12	
Canton, Mass.		
See Boston, Mass.		

FIG. 5. A PAGE FROM THE BELL SYSTEM'S NATIONAL TELETYPewriter EXCHANGE SERVICE DIRECTORY.

MODERN BUSINESS ADOPTS TELETYPEWRITER

REPUBLIC STEEL CORPORATION
 INVOICING DEPT.-COPY OF ORDER

REPUBLIC STEEL CORPORATION
 DISTRICT SALES-COPY OF ORDER

REPUBLIC STEEL CORPORATION
 ACKNOWLEDGMENT OF ORDER

REPUBLIC STEEL CORPORATION
 GENERAL ORDER DEPT.

COUNTRY WLC DATE ENTERED 9/24/55 DIST SALES CLIVE 2 BILL NO A-46009 SHEET NO 1 NO OF SHEETS 1
 CENT
 CHANGE TO JOHN DOE
 ADDRESS NEW YORK N.Y.
 SHIP TO SAME NEWARK N.J.
 COUNTRY WLC DIST NO R-1731 TENS REGULAR
 9/23/53
 CL CL 33/100# MIN WEIGHT 40 000 PRESENT COLLECT VALUE NOTE 253 CLASS NO 39 SCHEDULE NO 40
 ROUTE P R R
 SHIP FOR SHIPPING WEIGHT

LOADING AND UNLOADING AT BOX CAR LOOSE WELL BRACED
 MAKE OR PAINT

SHIPMENT DESIRED AT ONCE IN C/L SHIPMENT REQUIRED 10/3-10/5
 QUALITY TO BE USED FOR PIPE AND TROUGH PART OR TYPE NO.

SPECIFICATIONS GALVANIZED STEEL TITECOTE
 CONDITION OF MATERIAL ANNEALED
 SAME AS SPEC
 TOLERANCES
 COMM GA PREFER LIGHT SIDE

SECTION	TYPE	CLAS	ELONGATION	REDUCTION	STRENGTH
1	1000 SHTS	28 GA	X	26-1/2"	17 250
2	2000 SHTS	28 GA	X	30"	39 060
3	3000 SHTS	28 GA	X	30-1/4"	59 070
4					15 620

FIG. 6. THIS ORDER FORM IS TELETYPEWRITTEN IN QUADRUPLICATE AT THE YOUNGSTOWN, O., GENERAL ORDER DEPARTMENT OF THE REPUBLIC STEEL CORPORATION. AT THE RECEIVING POINT, WHICH MAY BE ANY ONE OF SEVERAL DISTANT MILLS, THE SAME INFORMATION IS REPRODUCED ON A HECTOGRAPH FORM, FROM WHICH ANY NUMBER OF COPIES UP TO TWENTY ARE RUN OFF FOR THE USE OF THE VARIOUS MILL UNITS. NOTE THE DEPARTMENTAL DISTRIBUTION INDICATED ON THE FORMS.

number for both office and plant units so that time-consuming and expensive checking is likewise eliminated.

Companies in many kinds of business have recognized the value of Teletypewriter Service equipped for multi-copy operation. As of recent date, 187 different concerns had adapted it to their special requirements. Of this number, 140 use it on a private line basis, 47 having Teletypewriter Exchange Service.

A typical application of the sprocket feed feature is described by the auditor of a food company as follows:

The order-writing system performs a simple enough function in the modern industrial organization, but lack of efficiency in one way or another usually affects the quality of both production and distribution performance. If orders are slow in arriving at the point where they are filled, customers are kept waiting; if they are inaccurate or not authentic, there is the same delay and also a probable loss of materials or slowing-up in the production machinery.

The requirements of a good order-writing system are few. It should be accurate and provide a check on this accuracy. Various agencies now in ordinary use readily provide one of these requirements. Messenger service, whereby the orders are sent from office to factory by boy, usually makes for accuracy. But there is a sacrifice of speed. The telephone provides a ready means of achieving speed in order transmission, but it is generally agreed that oral messages do not always have the authenticity of written ones. . . . The teletypewriter fulfills the two requirements of speed and accuracy.

The sprocket feed arrangement, which moves the carriage of the distant teletypewriter in perfect synchronization with the carriage of the one on which the communications are being sent, is so flexible that it can be adapted to the most complicated forms. These are usually fed into the teletypewriter from large packs, forms being interleaved with carbons. One pack will usually last several days, so that frequent replacement is not necessary. Both machines print a sufficient number of copies for whatever uses the particular routine may demand.

If the sender wishes to include figures or other information on his copies which he does not wish to appear on the copies at the other end, the forms can be so designed. Office copies may be printed with space for the in-

MODERN BUSINESS ADOPTS TELETYPEWRITER

formation wanted, and the corresponding space on the receiving copies "blacked out."

Orders which come into the office by telephone, telegraph, mail, and from the salesmen, are promptly turned over to the operator. The sending machine prepares four copies of each order—an original invoice, a book-keeping copy, a statistical copy and an office copy. Simultaneously in the factory the receiving machine prints four additional copies—a shipping order, a delivery receipt, a packing copy and an office copy.

This use of the teletypewriter has resulted in increased efficiency and considerable economy. The cost of messengers has been eliminated. Orders flow in a smooth stream from office to factory. The production department experiences no peak loads at certain times during the day; nor are there any idle periods. The order clerks in the general office may stay after regular office hours if necessary, sending orders which arrived too late to be sent while the warehouse force is working. The warehouse force, which goes to work an hour earlier than the office force on the following day, finds orders already at hand, and does not have to await the arrival of messenger or mail.

The president of a prominent automobile company cites his experience with the sprocket feed feature in an article entitled "Millions for Equipment—Not One Cent for Waste."

Teletypewriters were used in our big car plant to schedule the work and keep it flowing. When we laid out the new car plant we took every advantage of this experience. The variations and permutations possible even in so standardized a product as an automobile are almost infinite. Some 30 copies of engine specifications are necessary, including assorted variations for export shipments to conform with foreign traffic laws and meet the requirements of foreign methods of taxation. Comparable variations occur throughout. It is necessary to schedule the parts through the plant so that when they reach the assembly or sub-assembly lines the right parts meet the right assemblies. All this is handled by teletypewriter. The scheduling process has been so far refined that one chain conveyor brings radiator shelves, bonnets, front and rear fenders—in proper order and at the right moment. The entire production performance is at all times coördinated through this teletypewriter link between factory departments and the office.

BELL TELEPHONE QUARTERLY

FORM #10-100-100

HOOKLESS FASTENER COMPANY
26TH AND REED STREETS
PHILADELPHIA

PACKING SLIP

ORDER NO. #1634

FORM #10-100-100

HOOKLESS FASTENER COMPANY
26TH AND REED STREETS
PHILADELPHIA

DATE 9/24/35 OUR ORDER NO. N95-1234 CUSTOMER'S ORDER NO. #1634 FILE COPY

SOLD TO
JOHN SMITH AND

FORM #10-100-100

HOOKLESS FASTENER COMPANY
26TH AND REED STREETS
PHILADELPHIA

DATE 9/24/35 OUR ORDER NO. N95-1234 CUSTOMER'S ORDER NO. #1634 N. Y. OFFICE COPY

SOLD TO
JOHN SMITH AND CO
1405 MAIN STREET BROOKLYN NY
JACK BROWN INC
1350 BROADWAY BROOKLYN NY

PARCELPOST

HOOKLESS FASTENER COMPANY
26TH AND REED STREETS
PHILADELPHIA

DATE 9/24/35 OUR ORDER NO. N95-1234 CUSTOMER'S ORDER NO. #1634 ORIGINAL

SOLD TO
JOHN SMITH AND CO
1405 MAIN STREET BROOKLYN NY
JACK BROWN INC
1350 BROADWAY BROOKLYN NY

PARCELPOST

ITEM	QTY	SIZE	COLOR	LENGTH	W	TYPE	FABRIC	QTY	PRICE EACH	VALUE
1	5	L100K	AL	8 1/2	X		WHITE 211	1503		
2	6	L100K	NK	14	X		SEC CLACK 251	604		
3	35	SLCT	NU	4 1/2	X		SS FINK 201	35		
4	5	SLCC	AL	6	X		RED 821	432		
5	36	SLN	NK	8 1/2	X		FEACH 834L	605		
6	3	ELC	AL	15	X		SEC CHEST 511	1234		
7	5	ELC	NK	4 1/2	X		GREEN 501	829		
8	6	ET	NU	8 1/2	X		BABY 701	628		
9	36	SLDL	AL	15	X		CHEST 511	1892		
10	36	SLDL	AL	15	X		SEC WHITE 211	924		
TOTALS								8586		

SPECIAL INSTRUCTIONS:
NEW ORDER PHILA --SEND ADVERTAGS

ORDERED BY
DATE
CHECKED BY
DATE
LABELED
DATE
INVOICED BY
DATE
INVOICE NO.

TOTAL CHARGE

FIG. 7. THESE FOUR COPIES ARE RECEIVED AT THE PHILADELPHIA WAREHOUSE OF THE HOOKLESS FASTENER COMPANY. SIMULTANEOUSLY, THE NEW YORK HEADQUARTERS AND MAIN SALES OFFICE PREPARES ONE FILE COPY. NOTE THE DEPARTMENTAL DISTRIBUTION INDICATED ON THE FORMS.

MODERN BUSINESS ADOPTS TELETYPEWRITER

[illegible]

FIG. 8. ABOVE: THESE FORMS ARE PREPARED IN ONE OPERATION ON THE SENDING TELETYPEWRITER OF THE PHILLIPS JONES CORPORATION; THE PLANT AT POTTSVILLE, PA., SIMULTANEOUSLY RECEIVES FIVE ADDITIONAL COPIES. BELOW: THESE FORMS ARE RECEIVED AT THE BALTIMORE HEADQUARTERS AND PLANT OF THE SCHLUDERBERG-KURDLE COMPANY EXACTLY AS TYPED IN SALES OFFICES AT NEW YORK OR RICHMOND, VA. NOTE THE DEPARTMENTAL DISTRIBUTION INDICATED ON THE FORMS.

While the instances cited above indicate customer acceptance, they do not reflect the considerable effort and time expended by Bell System representatives in tracing details of operation and in working out these improved operating routines. In some cases the work is comparatively simple, in others several weeks or even months may be required to gather and analyze the facts and to prepare recommendations where it is apparent that there is a need for a service of this kind.

In one instance the Telephone Company representative found that a steel concern was dispatching orders from headquarters to its wire and sheet mills by telephone and messenger under the following conditions:

Four order clerks at headquarters prepared multi-copies of all orders. One man worked full time at headquarters telephoning advance information to the mills. This, in turn, required the full time of a man at each mill, in taking notes and dispatching preliminary advices to various mill sections. A messenger made two trips each day between headquarters and the mills, carrying the written confirmations of the same orders, which had been prepared in duplicate. When received at the mills the written confirmations had to be cross-checked with the pencil notations previously received by telephone. Sometimes errors were made which consumed considerable time in correcting and which were often costly. The routine caused two distinct daily peaks in production activities and slowed up delivery of customers' orders.

After these facts had been secured it was obvious that the installation of Teletypewriter Service equipped for multi-copy form operation would eliminate many inefficient features of the company's plan of operations. By applying teletypewriter it would be possible to reduce the number of full-time employees handling orders at headquarters from four to one. Men engaged in telephoning from headquarters and in taking down notes at the mills could be released to other work on a full-time basis. The order load would be eliminated from the messenger service so that the number of daily trips could be reduced from two to one. Checking of written confirmations against verbal advices would be no longer necessary. Peaks in the work load at the mill would be leveled off. As a result, customer service should greatly improve. In addition, the capacity of the Tele-

MODERN BUSINESS ADOPTS TELETYPEWRITER

typewriter Service would permit instantaneous general communication between units, making for increased all round efficiency. Needless to say, no difficulty was experienced in convincing the prospect that the service was highly desirable, and it was installed.

The foregoing illustrates some applications of teletypewriter business systems as related to comparatively short haul requirements. Over great distances other factors generally have to be considered. The following is a case in point:

A prominent clothing manufacturer, whose business required the preparation of voluminous paper records at sales office and plant in connection with all orders handled, was unable to give customers sufficiently rapid delivery service. Formal orders had to be mailed and received at the plant before shipment could be made. In addition, a considerable investment was tied up in stocks carried at strategically located warehouse depots.

A Telephone Company representative studied the routine of operation involved, tracing the course of an order from the time it was received until shipment was made and bill rendered. More than a score of separate operations were investigated.

It was found that the sprocket feed feature of Teletypewriter Service could be employed to handle all the required paper work. In addition, the fact that orders would be transmitted instantly to the plant would enable the manufacturer to give overnight delivery on rush orders. This solved the problem of customer service and the teletypewriter recommendation was adopted.

In a short time it was found that the economies which the service effected were sufficient to more than pay for its cost. In the first place, it was possible to substantially eliminate inventories maintained at a warehouse operated in conjunction with the sales office. The automatic reproduction of paper records at both sales office and plant permitted the transfer of employees to other duties. Less office equipment was required to handle orders. An even flow of orders throughout the day resulted in additional economies in production and shipping departments at the plant.

Consumer demand dictates continuous improvements in the technique of handling orders, inquiries and shipments. Cost and competitive situations require constant search for possible reductions in overhead. Teletypewriter Service, both private

BELL TELEPHONE QUARTERLY

KRAFT-PHENIX CHEESE CORPORATION

BILLING OFFICE COPY 5

BRANCH OFFICE COPY 4A

SALES DEPT. 4

DISTRIBUTION 3

BOOKKEEPING 2

SHIPPING ROOM COPY 6

SELLING OFFICE COST COPY 7

SHIPPING ORDER 8

KRAFT-PHENIX CHEESE CORPORATION

400 RUSH ST.,
CHICAGO ILL.

INVOICE NO. A51863

DATE

CAR NO.

DATE SHIPPED

VIA 500 PREPAID WED ONLY

11-27-38 GB A 51016

LOT NO.	QTY	PRICE	AMOUNT
1	6		
1	6		
1	6		

DESCRIPTION: KR 1/28 AMER, KR 1/28 PINT, KR 1/28 CREAMED OLD END

WEIGHT, PRICE, AMOUNT

FIG. 9. SIX COPIES OF THIS FORM ARE TYPED AT THE HEADQUARTERS OF THE KRAFT-PHENIX CHEESE CORPORATION. THE SAME TYPING SIMULTANEOUSLY PREPARES THREE COPIES AT THE DISTANT FACTORY. NOTE THE DEPARTMENTAL DISTRIBUTION INDICATED ON THE FORMS.

MODERN BUSINESS ADOPTS TELETYPEWRITER

THE D. L. & W. COAL COMPANY									
MINE SITUATION									
DATE	GRATE	EGU		S.DOVE		CHESTNUT		PEA	BUCK
		HOP	BOX	HOP	BOX	HOP	BOX		RICE
O.H. YESTERDAY 7 A.M.		75	6	137	45	173	109	113	69
MINED YESTERDAY									30
SCRANTON	1	46	2	94	36	119	32	48	61
WILKES-BARRE		46		91		97		36	52
HONEYBROOK		5		12		15		6	5
INDIVIDUALS									
LOADED AT STORAGES				189		34		203	187
TOTAL	1	172	8	483	81	438	141	1	16
BILLED YESTERDAY	1								3
R.R. CO. USE D. L. & W.						3			20
R.R. CO. USE C. R. R. N.J.						6			23
PIER 18		2		12		38		1	8
NOBOKEN		14		75		2			6
NEW YORK AGY.		31		4		27		5	10
BURNS BROS.		2		10		30		6	10
NEWARK C. N. J.		8		35		26		1	1
NEWARK D. L. & W.		8		29		38		2	7
SCRANTON		8		39		12		2	3
PHILADELPHIA		1		14	3	3		1	2
SYRACUSE-RAIL		3		6		3		1	2
" -TRESTLES		3		4		5		1	4
" -KELLY BROS		2		8		24		1	1
ROCHESTER		4		13		17		2	3
UTICA						16		1	2
OSWEGO		4	3	19	47	5		2	2
BUFFALO-RAIL						17		2	1
" -LAKE		14		26	1	17		1	1
" -TRESTLES		2		20	10	12		1	5
TORONTO		4		12		9			
ALBANY		2		14		5			4
HARTFORD		1		7	1	4		1	
BOSTON C. N. J.		2		9	16	2			
BOSTON D. L. & W.						1			
MONTREAL						1			
DETROIT								54	76
CHICAGO									35
MILWAUKEE									
WYOMING STORAGE									
HAMPTON									
TOTAL	1	110	8	372	78	300	45	102	168
O.H. 7 A.M. TODAY		62		111	3	138	96	101	19
SCRANTON-BLUE									14
" -BLACK		14		1		9		29	4
WILKES-BARRE-BLUE								23	15
" -BLACK		7				12		18	4
HONEYBROOK-BLUE		1		110	3	110	96		
HUMP		40							
ORDERS									
SCRANTON-BLUE	1	3	1	67	10	56	6	7	8
" -BLACK		4	1	146	9	75	7		6
REC'D BLUE									1
REC'D BLACK									
WILKES-BARRE-BLUE		6		72		106		9	2
" -BLACK		4		65		42		2	16
REC'D BLUE								1	
REC'D BLACK									
HONEYBROOK-BLUE		1		11		13			
" -BLACK									
REC'D BLUE									
REC'D BLACK									
TOTAL UNFILLED	1	9	2	150	10	164	6	17	2
BLUE		9	1	221	9	130	7	2	24
BLACK									
REMARKS	CNC=DLW ALL ORDERS ORDERED								

FIG. 10. THIS MINE SITUATION REPORT IS TELETYPEWRITTEN AT THE SCRANTON, PA., MINE OFFICE OF THE D. L. & W. COAL COMPANY AT 9:00 A.M. DAILY, AND FIVE COPIES ARE SIMULTANEOUSLY REPRODUCED AT THE MAIN SALES OFFICE IN NEW YORK, FOR THE USE OF VARIOUS DEPARTMENTS. AS ORDERS ARE RECEIVED DURING THE DAY AT NEW YORK FROM BRANCH SALES OFFICES, THIS REPORT ENABLES THE COMPANY TO DETERMINE AT ONCE HOW MUCH OF EACH ORDER CAN BE FILLED IMMEDIATELY AND WHAT ADDITIONAL PRODUCTION IS REQUIRED AT THE MINE.

line and exchange, has been valuable to industry in these respects, particularly where operating units are scattered over a wide area. The successful commercial application of equipment for "form writing," actually turning a communication service into a combination of office and communication services, demonstrates in yet another way how readily the teletypewriter can be adapted to the most exacting requirements.

The establishment of Teletypewriter Exchange Service opened up an entirely new communication field. It is used to transmit orders and specifications and shipping instructions, to handle financial and commodity market transactions, to interchange information relative to market conditions, prices, credit, purchases and general administration. A substantial number of these matters had previously been handled by other means. However, the service was so well adapted to various requirements that many industrial concerns modified their methods of operation to take advantage of its distinctive features. Consequently, a large portion of the communications which are now sent by this means did not exist and would not have originated had it not been for the introduction of Teletypewriter Exchange Service.

This form of communication is particularly advantageous to organizations whose requirements have not yet developed to the point where Private Line Service would be warranted. By utilizing Teletypewriter Exchange Service initially, they are later enabled to contract for Private Line Service with a minimum of rearrangement of their operating methods. Many concerns who already had Private Line Teletypewriter Service frequently have peak requirements during certain periods in excess of what can be handled over their private lines. Teletypewriter Exchange Service provides a means of handling this overflow, besides allowing for general intercommunication with other subscribers to the service.

J. M. TUGGEY, JR.

Answering Stockholders' Letters by Telephone

THE Treasury Department of the American Telephone and Telegraph Company is a primary point of contact between the Company and its stockholders. The Department is continuously busy with stockholder service. There are hundreds of changes of ownership each day through the process of stock transfers; every three months about 670,000 dividend checks are mailed; and the Treasury Department records yearly more changes of address than there are people in the average fair-sized American city. The transactions arising out of this activity are conducted through three main channels: first, by counter service in the lobby at 195 Broadway; second, by correspondence; and, third, by telephone.

An interesting experiment has been conducted during the past four years in transferring some of the replies to the incoming letter contacts from the correspondence to the telephone medium. This has been done principally to improve certain services rendered to stockholders, but also to give a model demonstration to many stockholders of the communication facilities of which they are part owners, and, not of least importance, to stimulate toll usage.

The experiment grew in a gradual manner from 1921 to 1930 out of experiences during the periodical offers of new stock to stockholders for subscription. Incoming telephone calls from stockholders increased enormously during the subscription periods and at the same time it became expedient to answer a few urgent letters by telephone. During the 1926 stock issue, incoming calls were concentrated at a central point, and during the 1928 issue a 120-line 8-position order table was installed. The result was that much speedier replies were given

and, because of a special course of instruction, a much better-rounded and more efficient service was furnished. Also, since the equipment was located near the point where letters were being handled, the answering of letters by telephone was more and more enlarged.

The 1928 experience was so successful for stock issue purposes that the equipment was again installed in connection with subsequent subscription offers, concluding with the 1930 stock issue. Since the latter work expired, the equipment has remained in the Treasury Department and has been the nucleus for the steadily increasing development of telephone contacts with stockholders.

1,000 LETTERS A MONTH NOW ANSWERED BY TELEPHONE

Upwards of 300,000 incoming calls have been received and handled in this unit since stock issue work subsided, exclusive of requests for stock market quotations, which, due to the interest in the Stock Purchase Plan of the Bell Telephone Securities Company, were rather numerous at first; but of greater significance is the fact that, during this same period and arising from meagre beginnings in conjunction with stock issues, approximately 50,000 letters have been answered by telephone, or an average of almost 1,000 a month. At the present time approximately 23 per cent of the correspondence with stockholders which requires answer receives telephonic reply. These letters have been of many types, some pertaining to transactions involving thousands of dollars' worth of telephone securities and some others giving simple information, such as dividend record dates, but practically all have been direct with stockholders or their representatives.

Concentrating the incoming calls at the order table resulted in several obvious advantages, particularly from the point of view of giving the specialized service which calls from stockholders deserve. It was found, however, that the calls were subject to peak-loads in certain hours of the day, and expand-



THIS 120-LINE 8-POSITION ORDER TABLE IS ONE OF THE MAIN POINTS OF CONTACT BETWEEN THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY AND ITS STOCKHOLDERS.



ing the use of the telephone in answering letters tended to occupy the slack periods resulting from this situation.

At the time this expansion occurred, it was not an original idea in the Bell System. Commercial service and sales promotion efforts had included it for many years. Also, business houses of many descriptions have for years used calls inside areas where it is cheaper to telephone than to write, and such houses have naturally answered letters from customers within these areas in the same way. It has, therefore, long been recognized that the telephone call has advantages in such directions as flexibility, speed, persuasiveness, and personal relationships.

The significant and original angles to the Treasury Department experiment lay in the extension of this previously accepted area and to the application of the telephone to financial and fiduciary correspondence, for which the written record was previously thought indispensable. Results obtained during stock issues, in terms of good service and better public relations, showed that a real opportunity existed to add a "personal touch" and to stimulate tool usage by furnishing a good sample product; at the same time, the results also proved that oral transactions in this field could be entirely satisfactory.

HOW THE TELEPHONE AREA WAS ESTABLISHED

After these conclusions were reached, it became necessary to determine within what distances routine calls might wisely be made and which correspondence topics might safely be handled by telephone. Several studies were made to help in reaching decisions upon these two problems. To begin with, about 1300 pieces of incoming mail were reviewed. Those letters better handled by printed or processed form reply and those letters which required as a part of the reply one or more accompanying forms were first eliminated. The remaining cases, after certain minor eliminations, amounted to 563, and the probable telephone cost required to answer these was com-

BELL TELEPHONE QUARTERLY

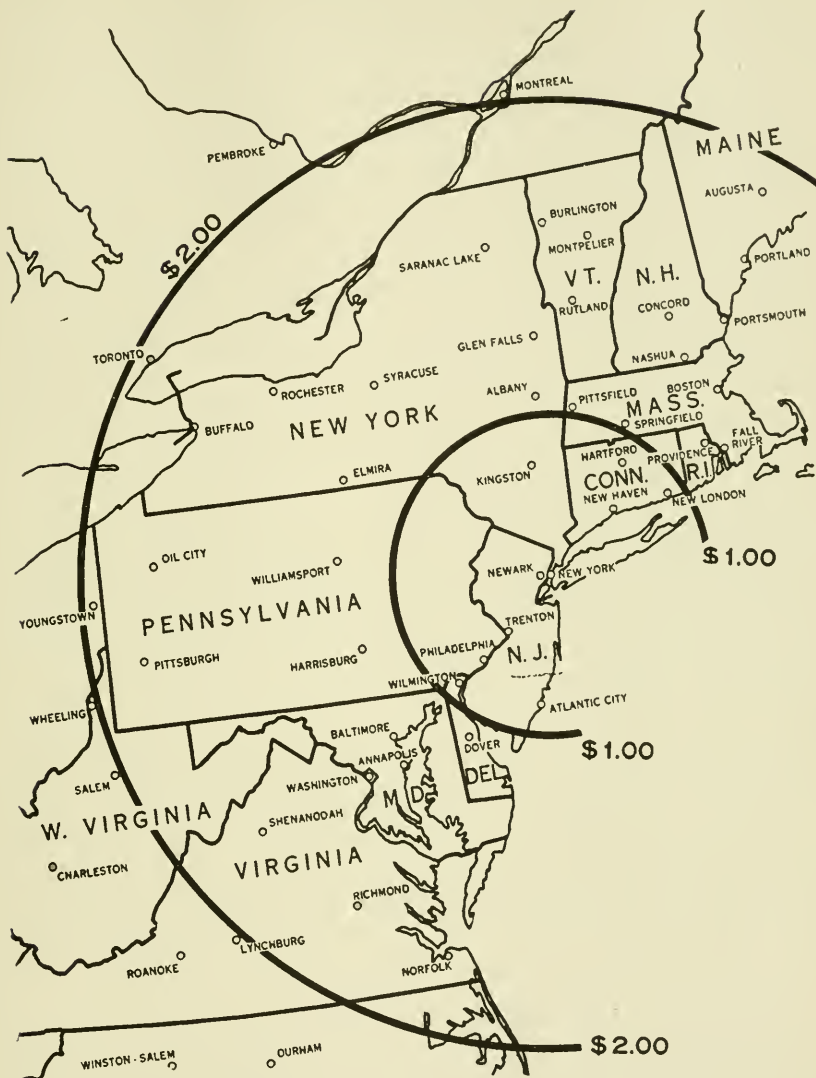
puted. This involved computation of the total cost and the per case cost of the actual number of cases within each regular commercial person-to-person rate band or zone, and, finally, computation of the cumulative cost per case in groups of zones. The results of this computation were as follows:

Rate Zone (Person-to-Person Rates)	Total Cases	Total Costs	Average Cost	
			Per Case in Each Zone	Per Case Cumulative
\$.0375-\$ 1.00	217	\$ 59.09	\$.27	\$.27
\$ 1.05-\$ 2.00	110	153.42	1.39	.65
\$ 2.05-\$ 3.00	52	129.05	2.48	.90
\$ 3.05-\$ 4.00	100	379.00	3.79	1.50
\$ 4.05-\$ 5.00	23	109.50	4.76	1.65
\$ 5.05-\$ 6.00	7	39.00	5.57	1.70
\$ 6.05-\$ 7.00	7	44.50	6.35	1.77
\$ 7.05-\$ 8.00	10	74.75	7.47	1.87
\$ 8.05-\$ 9.00	2	17.00	8.50	1.90
\$ 9.05-\$10.00	5	48.25	9.65	1.97
\$10.05-\$11.00	18	197.75	10.98	2.27
\$11.05-\$12.00	12	135.25	11.27	2.46
Totals	563	\$1386.56	—	\$2.46

The problem was to determine the point at which the importance of the subject matter of the average call would approximately balance with the average cost thereof. Such factors were given consideration as the speed required in handling the calls, the relative expense of the telephone personnel as compared with the personnel required to turn out written replies, and many similar factors. Some of the latter, however, were of such variable and intangible nature that it was not practicable to attempt an exact cost comparison of the two media, but it was felt that the greater production rate of the telephone tends to level off the costs to a comparable basis without taking into consideration other elements which favor the telephone.

More or less as an experiment, the area within which the person-to-person rate would not exceed \$2 was selected for the routine telephone calls. This area includes all of New Eng-

ANSWERING STOCKHOLDERS' LETTERS BY TELEPHONE



CALLS ARE MADE TO ALL POINTS WITHIN THE \$2 PERSON-TO-PERSON RATE ZONE, AN AREA IN WHICH 60 PER CENT OF THE STOCKHOLDERS OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY ARE LOCATED. IN ADDITION, CERTAIN CITIES JUST OUTSIDE THE ZONE, SUCH AS MONTREAL, WHEELING, AND LYNCHBURG, ARE CALLED.

land except the northeastern part of Maine, a portion of Canada including Toronto, all of the states of New York, Pennsylvania, New Jersey, Delaware, and Maryland, and about half of Virginia and West Virginia. Over 60 per cent of the stockholders of the Company are located within these bounds.

The average cost per call in the preceding table for this area is shown as 65 cents, but in actual experience over a period of years this has been somewhat less. It soon developed that a very considerable number of the calls could be handled on a station-to-station basis and it has been the accepted practice to originate as many station-to-station calls as possible. Bank officers, attorneys, and individuals whose letterheads show business, hotel or institutional addresses can be called at the lower rate with assurance of a high percentage of completion on the first attempt.

It should not be inferred from this description that the limited area needs to be too rigidly established. It is applied only to the routine or average correspondence calls. There are many emergency cases which warrant telephone treatment outside the \$2 area.

HOW THE TYPES OF LETTERS TO ANSWER WERE SELECTED

Selection of appropriate types of letters to answer by telephone was approached in a different manner. Originally only two kinds had been handled, one being those of an emergency character and the other being cases where additional information was required in order to reply properly by letter. Also, many of the first type were confirmed later in writing.

As the use of the telephone in answering general stockholder mail expanded, it was natural that new steps should have been taken cautiously and that simpler types of cases should have been attempted first. Telephone replies, therefore, were confined at the beginning largely to general inquiries from stockholders in which it was clearly obvious that a written reply would not be very necessary. There are always some stock-

ANSWERING STOCKHOLDERS' LETTERS BY TELEPHONE

holders, for instance, who are confused about the dates upon which they should receive their dividend checks. Letters arrive in all the non-dividend months of the year, ranging in tone from criticism over supposed carelessness to fear that the dividend may have been passed. These yield themselves to pleasant and successful telephone conversations with stockholders in conveying the correct information.

Other types of general inquiries which were answered by telephone in the early days of the experiment pertained to the dividend rate, general data concerning stock transfer requirements, acceptable forms for registering stock, certain Company practices regarding this, and complying with simple requests such as acknowledging change of address orders.

Although practically all of this correspondence may be called stockholder mail, it should be recognized that a fairly large percentage of it is received from representatives of the stockholders, such as banks, trust companies, lawyers, and brokers. In the quality of service which the Treasury Department endeavors to provide, no distinction is made between a letter received from a stockholder direct and one from a bank or other agent on behalf of a stockholder. However, the technique of handling telephone conversations with the professional representatives of the stockholders is different from that of dealing direct with the individuals. In fact, it may be said to be easier, since the occasional technical language required is more familiar to the professional man than to the average stockholder.

THE FULL LIST OF TOPICS

Results from these activities were favorable from several points of view, including that of giving effective answers to the incoming letters. The oral responses of the recipients were for the most part agreeable and there was exceedingly little aftermath of the calls, such as requests for confirmations or further letters indicating an unsatisfactory outcome of the con-

versation. This success led to additional types of letters being assigned for telephone treatment within the prescribed zones, and in 1931 the approved list embraced 33 general topics, including some of the most complicated and important mail handled by the Treasury Department with stockholders. The list may be summarized as follows:

1. General inquiries regarding dates, amounts and delivery of dividends; simple stock transfer requirements; acceptable forms for registering stock; procedure for registration and exchange of bonds.
2. Specific inquiries about lost, stolen or destroyed dividend checks; non-receipt of dividend checks; dividend amounts thought incorrect; changes of address where accounts cannot be located; changes of address where acknowledgments are requested.
3. Originating calls about stock surrendered for transfer where additional requirements must be fulfilled; specific inquiries about changes of name by marriage and about the delivery of stock certificates.
4. Originating calls about bonds surrendered for registration, exchange, or conversion where additional requirements must be fulfilled; specific inquiries about payment of coupons or interest and about the delivery of bonds.
5. Miscellaneous inquiries, such as market prices of Bell System securities, delivery of annual reports or proxies to annual meeting; follow-up of cases previously handled that are still incomplete.

The list of topics had almost a three-year trial, during which many interesting experiments were conducted and the technique of handling the calls developed and improved. As a by-product of the work, the existence of the telephone unit became known to banks and brokers having a large volume of business with the Treasury Department and this had the natural result

of increasing certain incoming telephone calls and thereby decreasing incoming correspondence.

It must not be concluded from this description that the expansion of the list of acceptable topics for telephone treatment has progressed without difficulties, nor that the full list approved in 1931 is still effective. As a matter of fact, the present acceptable list is somewhat smaller than in 1931 because experience disclosed that certain types of cases yielded partially unfavorable results. In measuring results of this new process, too much reliance could not be placed upon the idea that absence of complaints indicated success. The well-known tendency of the American public not to register its complaints had to be given some consideration, and imagination had to be used to picture how persons were reacting to the novelty of receiving long distance telephone calls in response to written business communications.

TESTS OF THE RESULTS OF TELEPHONE CONTACTS

The principal factors which have led the Treasury Department to believe its telephone treatment has been worth-while may be mentioned briefly as follows:

1. The percentage of cases where written confirmations of calls have been requested has been exceedingly small: less than one-half of one per cent.
2. The percentage of cases has been negligible where the telephone contact disclosed impracticable conditions for delivering the message, such as deafness or illness. (One attempt to reach a stockholder who proved to be deaf resulted in a sale of amplifying equipment.)
3. The voice tones and oral responses of recipients of calls have been favorable in the predominant number of cases.
4. The results of calls have been generally favorable where the cases involved subsequent action on the part of the stockholders.

Another factor, which was not exactly a test of the reception of calls but which was closely allied to it, was that the percentage of cases where it proved impossible to reach the stockholder by telephone was reasonably small: namely, 6.7 per cent. This covered such familiar reasons as "No Listing," "No Answer," "Temporary Disconnect" and the like. An amusing example of an unsuccessful attempt to reach a stockholder was one where the address was given as a certain number on Hunter Street in Ossining, New York. It was found that the only telephone at that address was listed for the state penitentiary and the management would not call the stockholder to the telephone.

TYPES OF LETTERS NOT ANSWERABLE BY TELEPHONE

Unfavorable results were usually determined from subsequent developments in connection with telephone replies revealing that the stockholder had only partially fulfilled the Company's request or had ignored or misunderstood it. Immediately unsatisfactory oral responses to calls have been so rare that it is difficult to recall an instance. From these reactions, however, it was learned by actual experience over a period of time that it was advisable not to give routine telephone treatment to certain types of cases. In general, these have the following characteristics:

1. Where the stockholder or his representative is asked to send the Company an affidavit or other document which should preferably follow the Company's own model.
2. Where the point under discussion is one of involved figures or registration of stock and any error or misunderstanding might require subsequent correspondence.
3. Where data being conveyed by the Company comprise too many items, such as the numerous requirements necessary in a complicated fiduciary stock transfer.

ANSWERING STOCKHOLDERS' LETTERS BY TELEPHONE

4. Where the data under discussion are of a technical nature and it seems the recipient is likely to misunderstand the technical terms.
5. Where the topic under discussion is a complaint or of a controversial nature.*

Throughout the many months during which these guideposts were being determined there were many interesting episodes and pleasant contacts, the most interesting of all, of course, being those which inspired appreciative remarks or tended to stimulate the use of the telephone. One of the most clearcut examples of the latter, but by no means a lone instance, was a call originated to an attorney in Buffalo, New York, about a stock transfer requiring some additional legal papers. After the subject matter of the call had been discussed, the attorney related that he had a case in his office on which it was necessary to consult with another attorney located in Washington, D. C., and he had been debating with himself all morning whether or not a telephone call would prove satisfactory. He stated that our call had convinced him that he could transact his business with Washington over the telephone and that he would put through the call immediately.

At other times the stockholders receiving calls, particularly in small country towns, are very much pleased, not only at receiving such prompt attention to their letters, but also over the experience of a long distance call. "New York? Oh! I have never talked to New York before" is a common response to such calls and there is no doubt that the thrill is recited to many of such stockholders' friends before it is relegated to a commonplace recollection.

^A * *Note:* It is frequently very desirable to handle these by telephone, but in dealing with stockholders, and particularly with their legal representatives, it has been found diplomatic that such calls be made by an officer of the Company. They are therefore not classified as suitable for routine telephone treatment.

SOME FAVORABLE REACTIONS TO SERVICE RENDERED

Reactions to the quality of the service being rendered are perhaps the ones most gratefully expressed. This may be because they come from stockholders who realize it is their own Company rendering such service. In tracing stockholders in order to forward dividend checks which have been returned undelivered, such responses are particularly common. In one memorable instance a stockholder was traced from a small New England town to several addresses in Philadelphia, thence to Norfolk, Virginia, and when he was actually located he was most surprised; first, because the Company had been able to find him and, second, because it took the trouble to do so.

One aspect of this work which in the experimental stages was thought to be a possible weakness was that a busy executive or professional man who took the trouble to write the Company a letter might prefer a written reply and might resent the interruption of an unexpected telephone message. Like many things in this world which seem obvious, however, this conclusion has not proved true in actual experience. In fact, some such calls have ended in the recipient inquiring about the Company's practice of answering letters by telephone and, after receiving a brief explanation, offering favorable comment or asking about the results.

Much additional evidence has been collected on this point. If the call being made is one of the accepted types for telephone treatment, it is usually of a personal nature. It frequently confers a favor upon or at least renders a valuable service to a stockholder or his representative, and more often than not there is dividend money or security value involved in the transaction whereby the correspondent profits through prompt attention. These factors usually set the tone for the receipt of the call, no matter how much of an interruption it may have been. This deduction is based on very thorough experimentation, including calls to many types of people. The housewife, maid, and

college student have been tried, as well as business men and prominent people. Among the latter have been officers of the army and navy, state and city officials, judges, actors, and musicians, a college professor of economics and international monetary authority, college presidents, one or two authors, and a famous comedian. No prominent stockholder has yet voiced an objection to such a call.

Proof that this work has contributed to the nation-wide efforts of the Bell System to stimulate toll business has been evidenced in several ways, but frequently by the comments and questions which arise daily in connection with both incoming and outgoing calls. Often the conversation turns to telephone usage. When it does, the Treasury employees handling the calls, of course, are not quite so rapid with their accustomed firm but polite farewells. Some samples of the kind of questions which are asked are as follows:

"How do I go about making a call to London?" (or it may be Paris, Honolulu, Java, or other overseas points).

"Can you hear well on a ship to shore hook-up?"

"How can I arrange a visit to a central office?"

"How much does it cost to call Portland, Maine?"

"How do I get a pass to a radio broadcast?"

When headline events occur in the outside world, stockholders who happen to be calling the Treasury Department, or are called by the latter, become quite friendly and gossipy, both giving information and requesting it about the latest developments in the current event. This happens invariably during such occurrences as the World Series baseball games, the international yacht races, championship tennis matches, or, more recently, during the Hauptmann trial and the Supreme Court's important decisions.

THE PERSONNEL

A very important element in successful telephone contacts with stockholders is, necessarily, the personnel handling the

calls. They need to be exceptionally trained in two distinctly different directions, one being the technique of conversing over the telephone in an agreeable though not too punctilious manner, and the other being a clear grasp of many different fields of information. Thus the post of telephone correspondent or specialist ranks high in importance in the Treasury Department's work. Candidates are carefully selected and trained, and have a thorough knowledge of all sections of the work pertaining to stockholders' records and stock transfer procedure, as well as a varied knowledge of many phases of Bell System activities.

Briefly, the general conclusions which may be drawn from the Treasury Department's four-year experience with the substitution of the telephone for the letter as a medium of answering stockholder correspondence may be summarized as follows:

1. The results as to quality of service in the average case handled are not merely "just as good," but are better.
2. The telephone provides actual money-saving economy in nearby areas.
3. Beyond the local areas the telephone enables the Treasury Department to render a rather conspicuous service, which emphasizes the "personal touch."
4. Telephone treatment of stockholder correspondence contributes to the nation-wide policy of the Bell System of endeavoring to stimulate toll usage.
5. This practice, over a period of years, is familiarizing an ever-increasing number of the Company's stockholders with a model sample of their Company's product.

J. K. TORBERT

Twenty Years of Transcontinental Service

MORE than eight hundred persons talk across the continent every business day over long distance telephone circuits. The connections are, in most cases, completed while the calling party holds the line. The ease and almost commonplaceness of transcontinental telephone conversations are apt to make us forget the beginnings of this service, initiated some twenty years ago, and the large construction project carried out at that time along lines indicated by new scientific developments. We may even lose sight of the constant effort which has been expended since that time and the consideration still being given to improving the efficiency of the plant and operating methods. This year marks an appropriate occasion to review the development of the present system of transcontinental lines and circuits, the first of which was dedicated to the public service in 1915.

The first successful coast to coast telephone circuit marked a very significant stage in a long struggle to extend the distance over which telephone communication could be conducted—a struggle which began with the two-mile line between Boston and Cambridge in 1876 and which, in 1911, had advanced to the 2200-mile line between New York and Denver. The opening of service between New York and Chicago in 1892 and between New York and Omaha in 1897 had been momentous events in this westward march of the long distance telephone. The facilities for making these earlier extensions possible were limited, in general, to large-gauge wires and the application of loading coils to them.

FIRST TRANSCONTINENTAL TELEPHONE LINE

Shortly after the invention of the telephone, a comprehensive national and international telephone service was envis-

aged, but no one knew how it could be accomplished. About 1910, the officials of the American Telephone and Telegraph Company decided that a definite project of providing means to give transcontinental telephone service should be undertaken and that the West and East should be connected by telephone not later than the opening of the Panama-Pacific Exposition in 1915. The engineers and plant men to whom the order was given to provide the service realized that while existing methods, facilities, and equipment constituted a good foundation for the job ahead, they were inadequate for the operation of such a long telephone circuit, and that new methods were essential. Hundreds of miles of wire remained to be strung and thousands of poles set, in order that a continuous circuit might be available between New York and San Francisco. This, in itself, was a large undertaking, but the unanswered question that kept arising was how to overcome the great loss which the speech currents would encounter. The need was for line circuits of improved electrical characteristics and for a repeater which at the end of a long section of line would take the weak electrical currents, which carried the human voice, increase their strength, and pass them on to another section of line without appreciable distortion or delay.

Research efforts were concentrated on this problem, and as a result new loading coils and methods were made available and there was developed a vacuum tube amplifying device which was destined to be of fundamental importance to the art of electrical communication. The design of this device, as constructed for use with the proposed transcontinental line, was similar in principle to the two-wire telephone repeater of today. It appeared that the application of the two developments just mentioned to lines of the types previously used for long distances would overcome most of the difficulty which stood in the way of talking across the country.

By the early spring of 1914, pole lines totalling about 600 miles had been built in the final sections between Denver and

TWENTY YEARS OF TRANSCONTINENTAL SERVICE

Reno and one group of four eight-gauge copper wires had been strung and loading coils installed at about eight mile intervals. In addition, wires had been strung and reloading and retransposing carried out on various sections of existing lines, in order that continuous circuits of the desired electrical characteristics might be available from New York to San Francisco. Cable was avoided as far as was physically possible because of the greater transmission loss which it introduced and the eastern open wire terminal was brought to within three blocks of the Hudson River. The amplifying devices, which had only recently been developed, were installed at Pittsburgh, Omaha, and Salt Lake City to overcome part of the loss to the speech currents caused by the 3300 miles of loaded copper conductors. The wires from both the East and the West were terminated at Chicago, Omaha, Denver, and Salt Lake City, and when connected at these points there was available a group of conductors with three repeater points giving the possibility of three direct telephone connections across the country. Further, it was possible at either New York or San Francisco to switch these transcontinental connections to other cities on the two coasts. Four telegraph circuits were also obtained from the wires used simultaneously for telephone purposes.

SERVICE OPENED IN 1915

With these facilities, telephone service across the continent was opened on January 25, 1915, with an impressive ceremony in which President Wilson participated. Various city officials in New York and San Francisco, Dr. Alexander Graham Bell, Thomas A. Watson, and executives of the telephone company also took part. Although the transmission characteristics of the circuits were the very best that could be obtained at the time, they were poor by comparison with present day standards. For example, the frequency band transmitted was only about 900 cycles wide, or far less than one-half of the band

now used. However, those who participated in the opening and subsequent public demonstrations marveled at the achievement and congratulated the telephone company on the excellence of the results. The transmission of speech across the continent narrowed the conception of the great distance between the Atlantic and Pacific Oceans.

REMOVAL OF LOADING WAS FIRST MAJOR IMPROVEMENT

Early in 1915 three repeaters were added to transcontinental connections and again in 1918 two more repeaters were installed on the wires, bringing the total number of amplifying points in a transcontinental connection up to eight. These and other improvements gave reasonably good telephone service over the circuits until 1920. This year marked the completion of a general program which had been undertaken some years before to improve the transmission substantially. The first step in this program had been the removal of the loading coils from the original eight-gauge open wire facilities. This permitted a large increase in the width of the frequency band transmitted and a resulting direct improvement in fidelity of transmission. Existing repeaters were replaced with an improved type and four new repeater points were established to make up for the increased loss caused by the removal of the loading. Telephone circuits with so many repeater points were without precedent, and the additions were made slowly because of the uncertainties as to the performance of such a circuit and the necessity of avoiding any arrangement which would react unfavorably on the transmission as it existed.

The overall result of this work was a reduction in the transmission loss on the circuit from 20 db to 12 db. This meant that the received power was increased from 1/100th to 1/16th of the transmitted power. At the same time the transmission variations due to wet weather were greatly reduced and the quality of transmission was much improved. More important,

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the way was opened to the future application to the wires of carrier telephone and telegraph systems, as described later, which would have been impossible if the loading coils had not been removed.

ESTABLISHMENT OF ADDITIONAL ROUTES

There was a steady increase in the demand for the use of transcontinental telephone service, so that as the years went on many additional wires were strung on the original transcontinental line through Denver, Salt Lake City, and Reno. Transcontinental lines over other routes were also constructed as the traffic increased, in order to protect the service by alternate routes and at the same time give other sections of the country more direct access to the improved network of long telephone circuits.

The three circuits originally provided on the central transcontinental route proved adequate to meet the service demands until 1923, when it became necessary to provide additional circuit facilities. In view of the fact that a large part of the business terminated at Los Angeles, it was decided to provide additional facilities over a line from Denver via El Paso and Yuma to Los Angeles, which was designated the "southern transcontinental route." This route was more than 200 miles shorter for much of the Los Angeles traffic and had the added service advantage of providing an alternate route for the east and west business through a territory relatively free from sleet storms. A non-loaded eight-gauge group of copper wire was completed on the southern route in 1923 and placed in service the latter part of that year.

In 1927 a northern transcontinental line by way of Minneapolis, Bismarck, and Helena to Seattle was placed in service. A fourth transcontinental line was established in 1930 between St. Louis and Los Angeles, using a route somewhat north of the southern transcontinental line, and passing

through Holbrook and Kingman, Arizona. Construction work had also been started in 1929 on other sections of line which closely paralleled the original transcontinental line between Denver and Salt Lake City and extended from that point direct to Los Angeles by way of Las Vegas, Nevada. This system of transcontinental routes has made it possible to give much better service and it provides a fundamental network on which circuits can be added as future requirements develop.

TOLL CABLE CIRCUITS ADDED TO IMPROVE RELIABILITY

As improved methods were developed, they were applied to the transcontinental circuits so that the quality of the service might be the best that available methods would permit. One important application of these developments was the substitution, as far as practicable, of wires in lead covered cables for the open wire conductors. The use of conductors in cables for long toll circuits developed rapidly following 1920, and as the cables were extended westward from New York, sections were added to the transcontinental circuits. In 1925 the New York-Chicago cable was completed and transcontinental services were placed on four-wire cable circuit facilities in that section. The result was greater freedom from interruption caused by weather conditions and improved transmission and stability.

In 1931, when cable facilities had been extended as far west as Omaha, some of the transcontinental circuits were placed on four-wire cable facilities from New York to that point. The completion of cable from St. Louis via Kansas City and Oklahoma City to Dallas provided additional points at which the open wire transcontinental routes could be connected to the cable system. In the meantime, cables had been installed from San Francisco to Sacramento and from Los Angeles to Whitewater.

Thus we find that whereas one of the most important

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engineering problems in the design of the original transcontinental circuits in 1915 was the avoidance of cable, every effort in recent years has been to place these circuits in cable in all long sections where it is available. This has been made practicable as a result of developments in cable circuit design. In some of the circuits about 45 per cent of the mileage is now in cable, while in the original circuits, cable was used for less than one-half of one per cent of the distance.

APPLICATION OF CARRIER TELEPHONE SYSTEMS

A major improvement in the transcontinental service came in 1926 with the placing in operation of carrier telephone channels between Chicago and Sacramento, Calif. These carrier systems resulted in large savings in the cost of telephone circuits, as by their use three additional circuits could be obtained from each pair of wires which had been suitably arranged for this purpose. Their use also made it possible to improve still further the clearness of transmission. As a matter of interest, sections of the original eight-gauge group of four wires which are still in use and which at first provided three telephone circuits, now provide nine circuits.

The carrier channels between Chicago and Sacramento were connected to four-wire cable circuit facilities between Chicago and New York and between Sacramento and San Francisco and gave a circuit which transmitted a frequency band about 2200 cycles wide. Added improvements in the carrier systems during the following years permitted greater circuit stability and better transmission and increased the reliability of service.

Requirements for service over all of the routes, described above, have grown until today there are more than 100 through telephone circuits across the western states which are available for transcontinental service. Nearly two-thirds of these circuits are provided by carrier telephone systems.

Of course, a great many of the calls which pass over these

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lines do not cover the complete distance across the continent, but there are established at present about 400 connections, involving over 800 persons, each business day between points on the Atlantic seaboard and points in the Pacific coast states. In addition, such radiotelephone connections as those from the eastern states to Hawaii, Japan, Java, and the Philippines and from the western states to Europe, South America, and Central America cross the country on these wires. Some of the telephone circuits are also used as parts of nation-wide networks specially provided for the transmission of music and speech for broadcast purposes, for transmission of photographs by wire, and for the operation of voice-frequency carrier telegraph systems, each of which provides twelve telegraph circuits.

TELEGRAPH DEVELOPMENT

The original transcontinental group provided only four telegraph circuits and these were operated over the same wires simultaneously with the telephone circuits. Although additional telegraph facilities of this kind have been obtained as open wire circuits were constructed to meet the telephone requirements, it was impracticable in this way to meet all of the demands for telegraph service. Furthermore, the increasing speed and other requirements of the improved telegraph services were calling for higher grade facilities. To meet this demand, high-frequency carrier telegraph systems were installed, each of which provided the possibility of obtaining ten high grade through telegraph circuits on a pair of open wires over which telephone service was operated simultaneously. By 1923, telegraph circuits of this type had been made available between Chicago and San Francisco. Today there are fifty through transcontinental telegraph circuit facilities provided in this manner in the area west of Chicago. These have been supplemented by voice-frequency telegraph systems, of

which there are now six in service, providing seventy-two through telegraph possibilities.

IMPROVEMENTS IN CIRCUIT LAYOUT AND OPERATING METHODS

When the first transcontinental circuits were placed in service, no direct circuit from Chicago or New York to San Francisco was set up because the number of calls did not justify it. It was necessary, when New York wished to reach San Francisco, for the connection to be switched at Chicago, Omaha, Denver, and Salt Lake City. Another factor which made it undesirable to operate a direct transcontinental circuit initially was the fact that no method was then available which would pass signaling currents around or through the telephone repeaters.

An important step toward improved service through better operating methods came on July 12, 1917, when, on account of increasing traffic and the availability of new developments, it became practicable to establish the first direct Chicago-San Francisco circuit, thus making unnecessary the switching connections at Omaha, Denver, and Salt Lake City. This direct telephone circuit was the longest in the country until December 22, 1923, when, with the opening of the southern transcontinental line, a Chicago-Los Angeles circuit was established, making a switch at San Francisco unnecessary. The first direct transcontinental circuits were placed in service in the permanent layout on December 21, 1927, when two New York-Los Angeles circuits were set up. These circuits were followed the next year by two New York-San Francisco circuits. This development toward direct circuits has been continued and has resulted in steadily improved speed with which customers are connected with those whom they are calling. The speed of service in the early years of transcontinental service was very poor compared with present day standards and it was

necessary for a customer to wait a long time after he had filed a call before the connection could be established. As late as 1926, the average day speed of service on much of this traffic was about twenty-five minutes. Today the average time required to complete connections under most conditions is about two minutes.

The provision of lines and the operation of service across such long sections of the country brings to the forefront the necessity of day-to-day coördination of effort, if the best results are to be obtained. On many connections, the circuits must cross twelve to fifteen states and the conditions to be met are naturally subject to considerable variation. Furthermore, the interconnection of the various lines provides means for alternate routings at times of interruptions. In short, the country-wide network of long lines is handled as one system and the messages "go through" if there is any possible way of establishing the connection.

SUMMARY

A summary of the changes and continuous improvements in transcontinental telephone facilities and service in the first two decades of its operation is really a summary of progress in many phases of long distance telephone service in this country during the same period.

Vacuum tube telephone repeaters used at three points on the transcontinental circuits were quickly applied to other lines until now we find over 100,000 installed throughout the country. Carrier current systems used so effectively on these long routes to increase the number of circuits that can be obtained from one pair of wires are also in general use. The substitution of cables for open wire along substantial parts of the transcontinental routes is an example of what has been done on a large scale in other sections. These items have contributed in large measure to clearer transmission and large savings in cost. The time required to complete connections has been

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steadily reduced, and rates have been lowered over the period so that the rate for a three-minute daytime New York-San Francisco station-to-station message, which was \$16.50 in 1919, is now \$9.00.

These evolutionary changes have all been in the direction of providing better transcontinental service at a lower cost to the public; and that these accomplishments have been of increasing value to the public is evidenced by the large increase in business handled.

J. J. PILLIOD

The Changing Years as Seen from the Switchboard

Editor's Note:

The interviews appearing under the above title in current employee magazines of the Bell System are reprinted here as affording an interesting supplement to "Opportunities for Women in the Bell System" which was published in the BELL TELEPHONE QUARTERLY for January, 1932. Previous installments have appeared in the last three issues of the QUARTERLY.

7. PERSONALIZED SERVICE AND PUBLIC RELATIONS

No one knows better than do telephone people what is meant by the words "personalized service" and "good public relations." No one knows better than they that, as applied to the telephone business, the two terms mean essentially the same thing.

The maintaining of good public relations means the making of satisfactory human contacts and this, in turn, means the personalization of the service. The personalization of the service means that each telephone employee makes it clear to every subscriber or other telephone user that, in common with every other telephone man and woman, he or she stands ready at all times to do his or her part in providing for the customer, as an individual, a service that is not only as nearly perfect technically as possible, but that is as pleasing as possible to the telephone user.

This is true whether the individual employee concerned is a plant man installing a telephone or repairing it at the subscriber's office or home, trimming trees along a highway or driving a truck upon it; a public pay station attendant; or a man or woman at a business office counter or desk. It is, in a sense, particularly true of the operator, for her contacts with the public, made over the telephone, are peculiarly intimate

and personal. These contacts, moreover, are far more numerous than all other contacts between telephone employees and the public they serve, their total running to more than 40,000,000 a day.

One cannot review the part which the woman at the switchboard has played in the development of telephone service, as the writer and his readers have been doing in the present series of interviews based on the experiences of early telephone operators, without becoming profoundly convinced that the idea expressed by the phrases "a personalized service" and "good public relations" is not a new idea.

As has been pointed out in the present series, and many times elsewhere, the development of telephone service in America has been a process of evolution. What has been true of the service as a whole has been equally true of the idea of creating good public relations through the personalization of the service. This fact becomes convincingly apparent as one studies the reminiscences of the several hundred early telephone operators upon which the present series of interviews is based. Some of these stories of pioneer telephone women express this idea by inference, in the picture they paint of their life at the switchboard. Some of them are much more explicit.

Miss Frances Oberbeck, who began her telephone work as an operator in St. Louis, Mo., in 1883, writes of her early experiences in words which clearly show that the spirit of the telephone operator was then exactly what it is today. She says:

In the early days there was little or no actual supervision in the central office. Rather, there was a general understanding that everyone was to do her best. We were all intensely loyal to the company. . . . Of course, we did not realize that we were pioneers in a great business, but we could understand that our work was most fascinating, and that the central office was the embodiment of everything that was wonderful. Because of these things we strove to improve our work ourselves, without supervision. I believe that attempts to personalize the service began in those early days

when a good manner and a soothing voice were our only protection against irate and profane customers who had become accustomed to swearing both at and with the boy operators.

Miss Oberbeck adds that the relations between the operators and most of their customers were very friendly and that the girls at the switchboard knew most of their subscribers by name and took pride in recognizing their voices. "It was not uncommon," she adds, "for an operator to spend much of her spare time studying the telephone directory so that she could memorize the numbers of subscribers, for in those days most of our calls were given by name only."

The recorded reminiscences of other early operators present an even more graphic picture of the informal relationship that existed between the women in the central offices and the public they served. Even in the larger cities, this relationship was not unlike that which exists in many small communities today, or that which is quite likely to be characteristic of the operation of a private branch exchange in a typical business concern. If anything, the voice contacts between the operator and the telephone user during that early period were more informal than those which will be found at any switchboard today, whether public or private.

Paging Bill Smith

When an operator answered a subscriber's signal, she was quite likely to hear something like: "Hello, Annie, give me Bill Smith—he's probably up at his lumber yard, but if you don't find him there, maybe he's gone home for dinner." And Annie—or it might have been Mary, or Louise, or Norah—got Mr. Smith.

In those early days, as far as the handling of traffic was concerned, telephone service was a service which personalized itself. So thoroughly was it personalized, as a matter of fact, that some subscribers fell into the habit of asking the operators, informally and as personal favors, to perform services which to-

day would be classified as far outside the scope of telephone service.

"A subscriber," writes Mrs. Catharine Moore, of her experiences as an operator in Chicago, which began in 1884, "would request us to awake him with a call at a certain time in the morning. Upon leaving his office, he would request us to make a note of the calls coming in for him during the next hour, as he was leaving the office and would return at the end of that time; or, if he were going home and someone was anxious to reach him, the call was put through to his residence."

Almost numberless are the instances, cited by these pioneer operators, which give evidence of the informality of the relations existing between the women at the switchboard and their customers. Not infrequently a housewife would call her favorite operator to say that she was about to take a nap and wished to be called at three o'clock or some other specified time. So trustworthy did the telephone prove as a substitute for a clock that now and then a woman subscriber would announce over the wire that she was putting a cake into the oven and ask that she be called in three-quarters of an hour, and reminded to take it out.

Some Unusual Services

But the telephone sometimes substituted for a nursemaid, as well as performing the functions of a chronometer. Mothers who wished to go out for afternoon tea or a meeting of the "Dorcas Society" would leave their babies near the telephone with the receiver off, optimistically hoping that if the infant awoke from its nap during their absence, it would cry and the operator, hearing its wails, would call up the mother at the scene of the festivities and tell her to go home and care for the youngster.

One pioneer operator reports that it was not at all unusual to receive a signal from a customer and, on answering it, to hear

a customer say: "Mary, please see if you can find Charles and have him bring home some hamburger steak for dinner."

So well did some of the operators know the telephone habits of their customers, that grocers, bankers and newspaper men, who had long lists of regular daily calls, often had only to make the initial call and the next person on the list was found waiting on the line as each call was completed, until all of them had been called.

In many central offices during those pioneer days, the operators provided what amounted to a news service. Not only did they furnish information in regard to fires, elections, sporting events and so on when requested to do so, but in many cases they voluntarily called their subscribers and informed them of any important news that "broke" unexpectedly.

"Once," remarks an operator from Iowa, commenting on an obvious disadvantage of this system of news dissemination, "we received the news that Queen Victoria was dead and another time that President Cleveland had been shot and the information was spread over the community by telephone. Both of these reports were false rumors."

One operator reports a practice which, although it does not appear to have been widespread, had at least great possibilities. She does not explain in detail how this rather unusual service was provided for, but confides that some of her customers had, at times, "visitors who simply did not know when to go unless the telephone rang," and hints that the visitations of these bore-some folk were sometimes cut short by prearranged calls from obliging operators.

Public Appreciation

Even when the services performed by the operator did not extend to any of the rather striking and unusual activities here described, they met with warm appreciation on the part of the telephone public. As is still the custom of some subscribers in the smaller towns and some who are extensive users of long

distance service or of particular public pay stations, many telephone users expressed this appreciation in tangible form. At Christmas time there came a flood of gifts from customers who wished to show their gratitude to the central office force, or to particular operators. Boxes of candy, bottles of perfume, flowers, gloves, handkerchiefs, groceries and even turkeys were among the more common gifts. One enthusiastic plantation owner in Louisiana called up his operator and announced that he was going to send her a barrel of sugar as a reward for giving good service. She gently but firmly declined the offer, with thanks.

Commenting on this method of showing appreciation for good service, Miss Emma J. Grady, of Old Point Comfort, Va., says:

As the forces increased, this practice gradually died out. In the old days it was done in the nicest possible spirit. In some of the offices located in the apple-growing sections of Virginia a barrel of choice apples was always to be found in a corner of the building where they would be kept firm and cool. On market days the farmers' wives brought in delicious apple pies to the girls who answered the rural line calls.

The most unique Christmas gift I can recall was at Staunton, Va. Answering a rap at the operating room door, it was opened to reveal, standing without, a young colored man in an immaculate white coat bearing a tray on which stood a large cut-glass bowl of egg-nog. The bowl was surrounded by small glasses, and twigs of bright holly were massed around the whole.

Miss Grady circumspectly adds that a consultation was held to decide what was to be done with the gift, and it was agreed that each operator would "take a wee bit when relieved for the day." So slowly did the supply of egg-nog decrease that it was decided to send the balance down to the Plant men. After that the decrease seems to have been accelerated.

Romance at the Switchboard

Not all of the rewards of this personal relationship between the operators and their customers were of a material nature.

Sometimes they took a form that was essentially emotional. What a deal of romance, for example, is wrapped up in the remark of a pioneer telephone woman from Ohio to the effect that "some of the operators were fortunate enough to win husbands through knowing their subscribers."

It seems a far cry from the telephone service of half a century ago, let us say, to the telephone service of today. Even in the smaller towns, an operator who "wins a husband" as a result of a romance begun over the wire is relatively rare. Strictly off the record, one may hazard the guess that, in most cases, a man who becomes the husband of a telephone girl must himself do the winning, and considers himself lucky if he succeeds in doing so.

In the larger communities, subscribers no longer express their appreciation of good service by presenting the operators with barrels of apples, bowls of egg-nog or proposals of marriage. Yet the public is not unappreciative, as the files of any telephone company will testify. Hardly a day passes without a letter from a telephone user who wishes to go on record in commending some operator, whom he does not know and probably never will, because she has given him the kind of service he has particularly needed.

"Times change," runs an old proverb, "and we change with them." Like most proverbs, it states a truth to which there are important exceptions. Telephone service has, indeed, changed during the past half-century, and in few respects more importantly than in the manner in which, in many localities, calls are handled at the central office. But the essential needs of the public for telephone service have not changed—they have merely increased and become more intense. The response of telephone people to these needs, in many communities, has changed in the manner in which it is expressed, but nowhere has it changed in the spirit which underlies it.

Indeed, the very changes in methods of handling telephone

traffic have been brought about by the necessity of meeting the changing needs of the communities and the individuals served.

Part of Telephone's Evolution

"Present operating practices, and the present relation between the operator and the telephone user, have come about gradually," said M. B. French, Traffic Engineer, Department of Operation and Engineering, American Telephone and Telegraph Company, when the writer called upon him for comment on this phase of telephone development. "Both are part of the evolution," he continued, "that has taken place in the telephone business as a whole. Changes have come as a result of changing conditions, and have been different in degree and nature in places of different size.

"In thousands of small communities, where there are relatively few telephones and where operating is relatively simple, there has been little or no change in the relation existing between operators and subscribers. There is still the same high degree of mutual understanding that formerly existed everywhere, even in the larger centers. This is a condition which the Bell System encourages, as it not only meets the service needs technically, but apparently meets them in a way that the public likes.

"In the larger places, however—and gradually in smaller places as they grow larger—the mere size of the list of subscribers, on the one hand, and of the operating force, on the other, make it practically impossible to render the same kind of personal service that can be rendered in small towns, where the operators are quite apt to be acquainted with the subscribers' names and numbers, their whereabouts and their personal service needs."

"But do you not think," Mr. French was asked, "that, although it is impractical and often impossible, as you say, to provide the same kind of personal service in the larger towns as

in the smaller ones, the service may still be called a personal service, although it is handled somewhat more formally? ”

As Communities Grow

“Yes,” answered Mr. French, “for the reason that the essence of a personal service is a kind of service that each subscriber will consider satisfactory to him personally. In the larger communities, the surest way of making the service satisfactory to each subscriber or telephone user is to keep the service as a whole up to a very high level. Increased complexity in the characteristics of telephone traffic, and in the equipment and operating arrangements required for handling traffic, makes it necessary to introduce more formality into the handling of calls. The more technical aspects of operation and service assume greater importance. Satisfactory high grade service becomes dependent on the use of carefully prepared operating routines and on effective supervisory attention.”

Mr. French digressed for a moment to point out that this change in the nature of service in the larger communities is not peculiar to the telephone business, but is found in all industries. In such places, he remarked, the clerks in shops, agents at the railroad stations and taxicab drivers are not, generally speaking, known by their first names, as they are in many smaller towns, or even by their last names. There is, as Mr. French said, a tendency on the part of the public to look upon these employees more or less as impersonal representatives of the industry in which they are engaged, and to judge the service, which they provide, on a less personal basis than in the smaller towns.

“However, even in the larger places,” Mr. French continued, resuming his discussion of telephone service, as such, “operating practices are designed with due regard to the importance of the personal attention factor in telephone service. A majority of calls, both local and toll, involve little in the way of unusual occurrence. On these calls it appears that the controlling serv-

ice consideration is prompt, accurate handling; there is no need for comment or questioning on the part of the operators. The major requirement, from the viewpoint of personal attention, is that the operators evidence an attentive and pleasing attitude.

When Something Unusual Happens

“Larger opportunities for personal attention to subscribers’ needs occur on calls which are unusual in themselves or on which something unusual happens. Such opportunities exist on the small percentage of calls on which there are errors, irregularities or delays. They exist in connection with requests for telephone numbers and requests for charges on toll calls. Of course they exist on calls placed in emergencies—fire or other disasters, accidents and burglaries. They exist on long distance calls, especially those on which there is difficulty in locating the particular person with whom conversation is desired. Other opportunities occur when subscribers speak to the operators about service troubles, either relating to the operating or to their telephone apparatus.

“On calls of this type, good service may depend largely on a high degree of personal interest and possibly special action on the part of the operator. The effort is made, through carefully developed practices and through day-to-day supervision, to impress the subscribers with the fact that the operators give them competent, effective and undivided attention until they have satisfactorily disposed of each call.

As to the Dial System

“The introduction of the dial system has had an interesting effect on work of this kind. The large majority of calls, already referred to as involving little in the way of unusual occurrence and a minimum of opportunity for personalized attention, are dialed directly by the subscriber and handled through the machine. This allows concentration on the manual boards, provided for the purpose of supplementing the dial op-

eration, of those calls on which there is the greatest opportunity for personalized attention and for service betterment. This concentration in itself tends to facilitate the satisfactory handling of these calls."

The process of development, or of evolution, which Mr. French describes, has resulted in what might seem to be a paradox: the de-personalization of telephone service, from the standpoint of the individual operator's acquaintance with the individual subscriber, has led to a service that, in the overall sense, is more personal than ever before. For the very reason that the operator does not know subscribers personally, she treats them all as if she were at their personal service. Just because she cannot, in a vast majority of cases, know how important a particular call may be, she handles every call as if it were urgent—as courteously, as promptly and as accurately as she knows how. That is her part in carrying out the Bell System's pledge of providing in this country "the most telephone service and the best, at the least cost to the public."

8. A SPIRITUAL PRINCIPLE

Behind the telephone there lies not only a physical principle, but a spiritual principle as well. This spiritual principle has found many forms of expression. When telephone employees seek words with which to give it form, they say: "The message must go through!" When representatives of the management of the organization which provides telephone service would express this principle, they use some such words as those of President Walter S. Gifford when, addressing a convention of the National Association of Railroad and Utilities Commissioners, a number of years ago, he said: "Our policy and purpose are the same as yours—the most telephone service and the best, at the least cost to the public." Whether expressed in the words of the employees or those of the management, this spiritual principle is essentially the same thing. It is directed toward the same unalterable objective of

providing at all times a telephone service that is responsive to the requirements of the public. Just as the telephone transmitter, the telephone current, and the telephone receiver are responsive to the vibrations of the human voice, so this spirit is responsive to human needs.

As human needs have increased, the spirit which has prompted telephone men and women to respond to these needs has broadened and deepened. In essence, it is the same spirit it was a half-century ago; in the manner of its expression, in the number of people among telephone employees whom it inspires, and the number of people among the telephone-using public who are affected by it, it has become a more potent force than, in the nature of things, it could have been during the first years of telephone history. This spiritual principle—let us call it “The Spirit of Service”—has been the product of growth. Generations of telephone workers, each in his own time and in his own way, have contributed to it. They have made it the potent force that it now is.

This series of articles has been based on reminiscences of men and women who, in the first years of telephone history, served at the switchboard and there played pioneer parts in the romance of telephone service. As the title of the series suggests, it is a view, in retrospect, of the changes wrought by the sixty years which have passed since Bell first demonstrated the truth of the physical principle of telephony. In these reminiscences, one might well expect to find written a record that would cast light on the growth of the Bell System tradition which has come to be called “The Spirit of Service.”

Plain and Unadorned Accounts

This record is, indeed, written in these personal recollections of the women—and the boys for that matter—who served at the switchboard during the pioneer days. But one has to search for it between the lines—these early operators are strangely reticent about discussing their own contributions to

the evolution of the spiritual principle that has played so important a part in telephone history. There is almost a complete absence of heroics in their plain and unadorned accounts of what they did and how they did it. They rarely tell of their own exploits. Now and then a woman writes of how, as a girl, she and her companions waded through drifts of snow to reach the central office, because they knew they would be needed. Here and there one finds references to some special case of sickness or accident which called for unusual resourcefulness on the part of those who served at the switchboard. But even such comparatively rare instances are recorded with a restraint which proves that these pioneer operators accepted an emergency, as operators do today, as merely another phase of their day-to-day job of giving the best service of which they were capable.

Three Operators' Reminiscences

"It is rather interesting," writes Miss E. Newell, of Stockton, Cal., "to note how the Spirit of Service was the keynote of our work as far back as 1897—'Give service, no matter what happens!' Everyone worked cheerfully any hours assigned, when the emergency arose. During the many floods common in those days, we worked twelve or fifteen hours. We took a great pride in giving good service under those difficult circumstances."

Over and over again, in these reminiscences of early operators, there is repeated, like a refrain, some expression of the satisfaction they feel in having had a part in the development of telephone service and of this spiritual principle that is built into its foundation.

"One impression which has remained with me," writes Miss Katherine Schmitt, who has been quoted in earlier interviews, "is the devotion of telephone employees to the company, to their work and to each other. Under the most trying circumstances, it steadfastly stands—just why, I do not know. An

elusive element—‘ the Spirit of Service ’—grips each one of us.”

So, also, writes Miss Elizabeth Harlle, who began her telephone career at Corsicana, Tex. just thirty years ago. Says she: “ I have often wondered how an organization employing so many people could get such a number of interested and loyal employees. I am proud of my connection with them, proud of the patience they have had in my development and the confidence they have shown in my ability.”

“ Just why, I do not know,” says the woman from New York. “ I have often wondered,” says the woman from Texas. Yet there is nothing mysterious about the devotion of telephone men and women to the service in which they are engaged. It is simply the response of human hearts and human hands to human needs.

Vail Medal Memorial Fund

Not infrequently, when this spirit of devotion to the interests of the public on the part of telephone operators has risen to unusual heights, it has been recognized by unusual rewards. The first gold medal ever awarded for “ Noteworthy Public Service ” from a fund created to honor the memory of the late Theodore N. Vail, twice president of the American Telephone and Telegraph Company, was given to a woman—Mrs. Mildred Lothrop. When the Omaha Creek overflowed its banks and swept through the streets of the little village of Homer, Neb., on the night of May 31, 1920, Mrs. Lothrop remained at her switchboard, telephoning subscribers in the path of the approaching flood and warning them to flee to places of safety. In imminent danger, she continued to send out her warning until the rushing waters covered the floor of her little office and, mounting steadily, washed over the shelf of the switchboard, putting the wires out of service. Only after further service had become impossible did she seek her own safety, when she had to wade through water breast-high in order to escape from the rapidly rising flood.

The medals provided from the Theodore N. Vail Memorial Fund are not presented to Bell Telephone company employees alone, but also to other telephone men and women whose acts merit recognition as being of "Noteworthy Public Service." Such was Miss Gladys I. Gibson, a private branch exchange operator and heroine of a disastrous fire which occurred at a mid-western medical institution in 1929. Two minutes after the blaze broke out, an operator at the central office, upon answering a call, heard a voice crying: "There's a fire here at the hospital—a terrible explosion—call the fire department, the police, ambulances—it's awful—and—"

The voice, afterward identified as that of Miss Gibson, ceased abruptly. Choking and gasping for breath as the fumes from the fire surrounded her, she had sounded a warning which beyond doubt prevented the loss of life in the disaster from mounting still higher. She gave her life for the lives of others. The gold Vail medal awarded in recognition of her heroism was the only national award ever granted posthumously.

Although the establishment of the Vail Memorial Fund afforded a new form of recognition for such acts of "Noteworthy Public Service," the spirit of devotion for which they were awarded was by no means new. The records of the first decades of telephone history are incomplete in this respect, as they are in many others, but there is in them enough to make it abundantly clear that in those days of small beginnings, as at present, emergencies arose which called for an unusual degree of resourcefulness, initiative and devotion to the service on the part of telephone operators. Human needs existed, then as now. Then, as now, human hearts and hands responded to them.

The Story of Sally Rooke

There are stories of devoted heroism which time has not obscured, nor will, so long as deeds of courage continue to thrill the hearts of men. One of these epics of telephone history has

its setting in the little New Mexican village of Folsom—a ranch-country town on the banks of a stream called the Dry Cimarron. The time is the night of August 27, 1908—twenty-seven years ago.

In her cottage on the main street of Folsom, Mrs. Sarah J. (Sally) Rooke, sixty-eight years of age, was attending the switchboard of the local telephone exchange. During the evening, rain had begun to fall throughout the Dry Cimarron Valley. Gradually the waters of the creek had risen, but this had happened before, and there was no apprehension of danger. About ten o'clock, however, Mrs. Rooke received a call from a ranch house ten miles up the valley, which at that point narrows to form a canyon, informing her that a cloudburst had occurred and that a tremendous volume of water was rushing down the river.

Sensing the danger, Mrs. Rooke began calling ranch houses known to be in the path of the advancing flood, above the village; then the subscribers in Folsom itself; then those farther down the valley. Repeatedly she refused to leave her post, explaining that she must warn other ranchers still farther down the Cimarron.

The flood struck. Buildings were shattered, torn from their foundations and borne like chips upon the surface of the raging wall of water which raced down the valley. Amid the wreckage of the little building which was to her both home and post of duty, this gray-haired heroine of the switchboard was swept away to her death. Seven months later, on a ranch eight miles below the village, half-buried beneath the debris which the flood had deposited far above the stream's normal banks, her body was found.

Today there stands over her resting place a granite monument, erected from funds contributed by more than 4,000 donors, most of whom were telephone employees. It bears the inscription: "With heroic devotion she glorified her calling by sacrificing her own life that others might live."

"Soldiers of the Switchboard"

One of the stirring tributes to duty well performed during the World War was that which General Pershing paid to the women telephone operators who served with him in France. Perhaps it was the highest honor ever accorded to the women of the switchboard—except that which General Pershing had paid, early in the war, when he insisted that the operators who were to serve overseas must be women.

Writing later of this important phase of his experiences in the war, General Pershing said:

One of the crying needs when we once began to use our own lines was for experienced operators.

Instead of trying to train men of the Signal Corps, I requested that a number of experienced telephone girls who could speak French be sent over, and eventually we had about 200 girls on duty. Some doubt existed among members of the staff as to the wisdom of this step, but it soon vanished as the increased efficiency of our telephone system became apparent.

No civil telephone service that ever came under my observation excelled the perfection of our system after it was well established. The telephone girls of the A.E.F. took great pains and pride in their work and did it with satisfaction to all.

These "soldiers of the switchboard" had been selected from thousands of young women who had volunteered for service, and were thus representative of their sister operators. This well earned tribute to their devotion was more than a personal tribute to them, individually or as a group. It was a tribute, rather, to the American telephone operator, past, present and future. For the spirit which inspired these young women who served in France was the spirit which inspires every telephone operator, always,—the spiritual principle which prompts them to respond to human needs.

Out of the Doing of Daily Duties

Wartime patriotic fervor alone cannot explain this spirit. Nor can it be explained by the inspiration that comes from

being faced with emergencies which must be met. Rather, it arises from an unconscious habit of mind that grows out of the doing of daily duties, many of which must often appear humdrum and prosaic, as if they were being done under extraordinary or inspiring circumstances. A telephone operator never knows—and in a vast majority of cases never will find out—what issues of life or death may hang upon the promptness with which she answers “Number, please” in response to a signal at her switchboard, or upon the swiftness and sureness with which she establishes a desired connection. All that she knows is that, be it great or small, there is a human need behind each signal, and that it is her calling—the calling “glorified” by Sally Rooke and thousands of others—to respond to this need.

What we have here chosen to call the spiritual principle is the foundation of telephone service. That no one knows this better than the Bell System’s chief spokesman, the President of the American Telephone and Telegraph Company, Mr. Walter S. Gifford, is shown by his constant tribute to the System’s personnel. “The greatest asset of the System,” he once said, “is the skill, energy, and character of the men and women who make up its organization.” And in reporting to the stockholders last March the operations for the preceding year, he concluded his summary with this significant paragraph:

“The message must get through.” There is embodied in those words an ideal ever present in the minds of telephone men and women. Fifty-nine million messages a day “got through” in 1934, and service standards were the highest on record. This achievement evidences the skill and enthusiasm of the quarter of a million men and women of the Bell System who are devoted to an essential public service, in which over-all success is so dependent on the efforts of each individual.

And with this sentiment, that epitomizes the philosophy of the Bell System, is closed the series of chapters that review “The Changing Years as seen from a Switchboard.”

R. T. BARRETT

Changes in Birth and Death Rates as Affecting Population Growth

POPULATION growth in the United States since 1930 has been very largely due to the excess of births over deaths and in view of the probable continuation, for an indefinite period, of present restrictions on the admission of aliens, it seems reasonable to assume that future gains will depend almost entirely upon the natural increase of the population. Growth from this source, however, has been declining very rapidly in recent years; a drastic drop in the birth rate alone accounts for this decline and the downward trend of the birth rate shows hardly any tendency as yet to slacken. Furthermore, the expectation of a gradual rise in the mortality rate before many years introduces the prospect of at least a temporary period of very nominal population growth in the not far distant future.

In a country where the business community has grown up largely under conditions of an uninterrupted increase in population and rapidly expanding markets, some adjustment of established conceptions of future production and consumption may be necessary to conform with the reality of a declining rate of population growth. The growth of the telephone industry, however, does not depend so much upon mere numbers as upon the qualitative characteristics of the population, and if an improved standard of living accompanies the retardation in rate of population growth, then the increased volume of business due to a greater penetration of the potential market for telephone service might readily more than offset the effect of a numerical decline. In any event, a thorough knowledge of recent and prospective changes in population growth is im-

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portant to those responsible for engineering plans, commercial programs, and general market studies.

VITAL STATISTICS: HISTORICAL BACKGROUND AND ACCURACY OF REGISTRATION

The vital statistics of many American states and cities have been collected for several decades, but the beginning of Federal coöperation in developing a national and systematic plan for the recording of such statistics dates back only to 1902, when Congress passed the act establishing a permanent census office which contained a section providing for "the annual collection of statistics of births and deaths in registration areas for the year 1902 and annually thereafter." The act limited the collection of such statistics to those states which possessed "registration records affording satisfactory data in necessary detail."

Following the passage of this act, the Bureau of the Census with the coöperation of the American Public Health Association drafted an outline for a standard or model state law for the registration of deaths, and began a campaign which had for its goal the extension of the registration area to cover all states. After a state legislature had enacted an acceptable law, and the registration machinery therein provided for was set up and put into operation, the Director of the Census regularly made tests to determine whether the registration of deaths was complete, or sufficiently so for statistical purposes. If it was, the state was admitted to the registration area.

In 1902 there were only ten states and the District of Columbia that met the Federal requirements for the registration of deaths. (The recorded death statistics for these states date back to 1900.) However, additional states gradually qualified for admission until in 1933 every state was included in the death registration area. This means that the machinery is now in operation for registering every death in the United States as it occurs and for recording the disease, accident, or

violence that caused the death; also the age, sex, occupation, and nativity of the decedent. A birth registration area was similarly established in 1915 and steadily expanded until in 1933 every state was included. Thus, for the first time in our history the birth and death registration areas are now complete for the entire United States. The availability of birth and death statistics on a national basis is important, as these data not only measure the natural increase of the population of the country but, when combined with immigration figures, also indicate approximately the total population growth.

Under the best of registration systems some deaths, especially those of very young infants, escape registration; but few deaths, if any, are registered more than once. As a result, the number of deaths registered is somewhat less than the true number. Omissions are probably most common in states which have recently been admitted to the registration area and in rural districts, especially those that are very sparsely settled. Perhaps registration requires for its effective administration a certain minimum density of population. In most states the records are improving, and this tendency toward improvement will doubtless continue now that the effectiveness of the system can no longer be adversely affected by the admission to the registration area of new states with less complete records.

A Federal census is more likely to understate than to overstate the population because omissions are more common than false returns or double entries, but a census is probably nearer the truth than American registration of births or deaths. If that is so, the accuracy of birth registration can be roughly checked by comparing the births registered in the 12 months preceding the date of a decennial census with the number of children reported by the census as being under one year of age. This test indicates that births were not so well registered in 1930 as in 1920, probably because the rapid extension of the birth registration area was attended by a deterioration in the

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over-all efficiency of registration. However, of the 36 states which in 1930 showed varying degrees of deficiency in birth registration, 21 had joined the registration area since 1920, and 11 of the others had displayed substantial improvement over their 1920 record. This development suggests that birth registration in the United States is tending to become increasingly efficient.

THE MORTALITY RATE

The American death rate over a series of years is unknown, but there are two approximate measures of it. One measure is the death rate of the d.r.s. 1900¹ for each year between 1900 and 1934; the other is the death rate of the d.r.a.¹ over the same period. The former has the advantage of covering a constant area in which relatively few deaths were unreported; it has the disadvantage of not including any state south of the Potomac or west of the Mississippi, and so is not representative of the whole country.

The death rate in the d.r.s. 1900 was 17.2 per 1,000 in 1900 and 11.0 in 1934, while the rate in the expanding registration area was 17.6 in 1900 and 11.0 in 1934. The death rate of the United States as a whole in 1900 was evidently not far from 18 per 1,000, so the rate has fallen by about 40 per cent since the beginning of the century. It is conservatively estimated that not fewer than 4,000,000 lives have been prolonged since 1900 by the fall in the death rate.

This remarkable improvement in mortality experience reflects the tremendous progress of medical science in combating disease and in prolonging life. The most important achieve-

¹ The area from which statistics of deaths are received and which expanded between 1900, when the record began, and the present time is known as the death registration area, or d.r.a. The District of Columbia and the states included within this registration area, but excluding registration cities outside of the registration states, are called collectively the death registration states, or d.r.s. To make the meaning certain, the phrase must be followed by the year for which the figures speak; thus d.r.s. 1900 means the 10 states and the District of Columbia which comprised the death registration states in 1900.

ment in the crusade against disease and death has been the great reduction in infant mortality, primarily due to increasing control of the so-called "common" diseases of childhood—measles, scarlet fever, whooping cough and diphtheria—illnesses once thought inevitable. The annual average ratio of infant deaths per 1,000 live births in the registration area declined from 97 in the 1915–19 period to about 60 in the 1930–34 period.

There is no conclusive evidence that human life at its best extends through more years than it did in former generations. But if the average lifetime is lengthened, even though the maximum is not, the duration of group life is prolonged. In the United States life expectancy at birth has increased very materially during the past several decades until at present the figure is about 60 years, and it is believed that the ultimate limit in extending the average span of life has not yet been reached.

The ages of persons dying are published for 5-year age periods, but because of the numerous deaths at the threshold of life the first group is broken into two parts: children under one, and children one to four years of age. As shown in the first two columns of Table 1, in 1900 the deaths under one year of age in d.r.s. 1900 were more than one-fifth, while in 1930 they were less than one-tenth, of the entire number of deaths at all ages. Deaths under 10 years of age in 1900 were about one-third, but in 1930 were little more than one-eighth of the total; deaths over 60 years of age in 1900 were three-tenths, but in 1930 were nearly one-half of the entire number. In fact, the proportion of deaths in each age period under 40 was lower in 1930 than in 1900 and higher for all age groups above 40. These changes reflect the aging of the general population from a median age of nearly 23 in 1900 to between 26 and 27 in 1930; they also reflect the improvement in the medical care of young people during this period.

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There is need of studying not only the age distribution of deaths, but also death rates by age, that is, the average number of persons dying annually at a specified age among each 1,000 persons living at that age. The most marked fall in the death rate between 1900 and 1930 was at ages one to four; the 1930

TABLE 1

PER CENT DISTRIBUTION OF DEATHS AND DEATH RATES BY AGE GROUPS IN D.R.S.
1900: 1900 AND 1930

Age in Years	Per Cent Distribution of Deaths		Deaths per 1,000 Population	
	1900	1930	1900	1930
Under 1.....	20.79	9.27	162.17	68.07
1-4.....	9.48	2.84	19.80	4.84
5-9.....	2.70	1.54	4.65	1.93
10-14.....	1.59	1.11	2.98	1.42
15-19.....	2.56	1.77	4.84	2.35
20-24.....	3.80	2.46	6.81	3.28
25-29.....	4.25	2.65	7.89	3.68
30-34.....	4.09	3.01	8.57	4.32
35-39.....	4.19	3.80	9.70	5.38
40-44.....	4.02	4.49	10.98	7.31
45-49.....	3.92	5.42	13.20	10.26
50-54.....	4.35	6.54	17.01	14.58
55-59.....	4.71	7.46	23.45	20.88
60-64.....	5.26	9.02	31.91	30.96
65-69.....	5.72	9.67	47.12	45.02
70-74.....	5.89	9.89	69.79	66.97
75-79.....	5.40	8.42	104.79	102.25
80 and over.....	7.28	10.64	337.20	322.00
All ages.....	100.00	100.00	17.16	11.52

rate at these ages was only about one-fourth of the 1900 rate. The last two columns in Table 1 show that the healthiest period of life as measured by the death rate is 10 to 14 years of age, while the least healthy periods are early infancy and the years beyond fourscore. As a result of the changes indicated in this table, the average length of human life and the years

of life resulting from a unit number of births have increased. This increase is one statistical measure of human progress.

The influence of age upon the death rate is so great that it tends to overshadow the effect of other factors, such as the sex, marital, and nativity composition of the population, and its distribution between urban and rural areas. Variations in the death rate might be better understood if the significance of these minor influences were considered briefly.

The male deaths reported in d.r.s. 1930 outnumbered the female deaths by more than 125,000. But as the estimated number of males in those states exceeded the females by nearly 1,400,000, the larger number of male deaths might be ascribed to the excess of males in the population. Male deaths, however, were nearly 55 per cent of the total deaths, but males formed not quite 51 per cent of the population. Furthermore, only three-fourths of the states had more males than females in their population, but every state reported more male than female deaths. It seems clear, therefore, that the death rate of males was higher than that of females in 1930. And, finally, between 1900 and 1930 the death rate of males in d.r.s 1900 decreased less than that of females, so the difference between the two sexes in this respect increased during that period.

Another factor to be considered involves the effect of marriage upon the rate of mortality and raises the question: how does the death rate of groups of the same sex and age vary with marital condition? The only data available on this subject are for the d.r.s. 1924 covering the five years 1924 to 1928, but the conclusions are interesting and have considerable significance. Among young men 15 to 19 years of age the death rate of the single was less than that of the married, but at every age above 20 the death rate of husbands was below that of any other class, and at ages between 35 and 50 it was about one-half that of bachelors. This difference is due in large part to marital selection, as young husbands doubtless are healthier

on the average than men of the same age who do not marry, but probably a contributing factor is the beneficial influence of married life. On the face of the statistical records, marriage affects the death rate of women less than that of men. At ages under 35 wives have a higher death rate than single women, perhaps because the favorable effects of marital selection are more than offset by the dangers incident to child bearing. At all ages above 35 the married women enjoy a lower death rate than spinsters.

There is considerable variation in death rates between the native whites, the foreign-born whites, and the negroes. In 1930 the native whites had the lowest death rate (9.6), while the foreign-born whites were at the other extreme with 19. However, when allowance is made for the higher median age of the foreign-born—in 1930 it was 44 or 45 compared with 23 or 24 for the native white—then the differential in death rates largely disappears. The negro death rate was 16.5 and since the median age of the negro race was practically the same as for the native whites, the higher death rate must be explained by other causes, probably a generally lower standard of living combined with a greater susceptibility to certain diseases.

Since 1900 the urban death rate has fallen much more rapidly than the rural, but still exceeds the latter by an appreciable amount, probably by at least 10 per cent. The public health movement, which is supposed to have played a large part in reducing the death rate, has probably had more influence in cities than in the rest of the country. Another factor tending to lower the death rate in the cities faster than in the rural areas has been the heavy migration of youths and young adults from the country to the cities. In this connection there is probably some degree of validity to the theory of selectivity of migration from rural to urban areas which postulates that the stronger or healthier element among the rural youth tends to migrate to the cities in disproportionate num-

bers, while the weaker element tends more to remain in the country.

The gradual though steady decline in the over-all death rate during the past 20 years cannot continue much longer for several reasons. In the first place, it seems probable that the most rapid rate of contribution of medical science to disease prevention and improved health has been realized, especially in the case of children. Furthermore, the increase in the older age groups where the specific death rates are high (the number of persons over 65 years of age increased by 34 per cent between 1920 and 1930, whereas the number of children under five declined by one per cent) and the steady advance in the average age of the population will, if continued, inevitably result in a gradual reversal of the present downward trend in mortality.

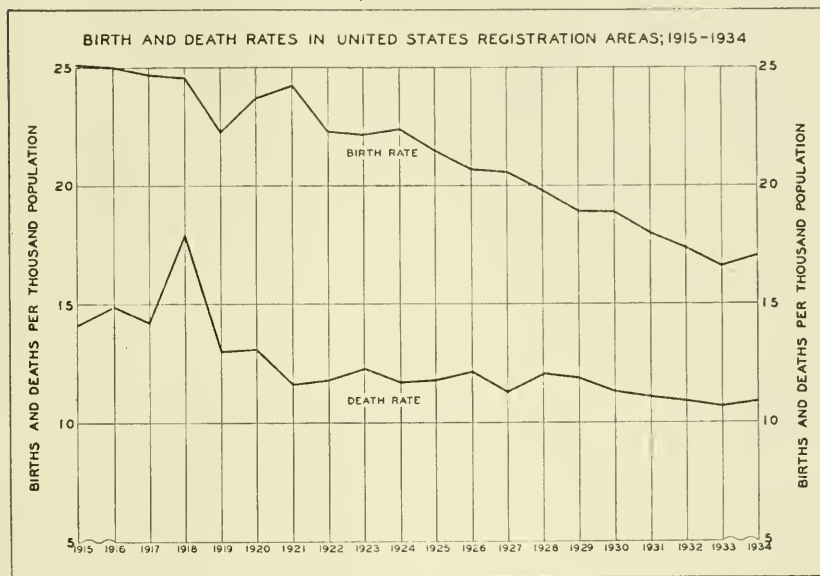
Another reason for expecting an increase in the mortality rate is due to the fact that, in a situation where there is little or no excess of immigration or emigration, the current death rate of 11 per 1,000 implies an average span of life of over 90 years, whereas the present expectation is not far from 60 years, which is equivalent to a death rate of about 17. It should be quite apparent that the present low death rate is possible only because of the unevenness in the age distribution, which consists of a concentration of a disproportionate number of people in the middle age groups where the specific death rates are relatively low.

THE BIRTH RATE

The birth rate in the United States has been declining very rapidly during the past twenty years from about 25 births per thousand of estimated population in 1915—when comparable statistics first became available—to 17.1 in 1934, a drop of nearly one-third, with the decline much more precipitous in the last ten years. The 1934 rate represents a gain of three per cent over 1933, which had the lowest birth rate ever re-

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corded in this country. These changes in the over-all birth rate, as well as variations in the over-all death rate since 1915, are shown graphically in the accompanying chart.²



Under conditions of severe economic depression, the birth rate fell more rapidly than it probably would have declined under normal conditions and the slight tendency (in 1934) for births to increase represents a temporary and minor adjustment due principally to two factors, namely, (1) the sharp increase in the national marriage rate in the last two years, a reversal of the decline which set in following 1929, and (2) the strenuous campaign carried on during 1934 to attain more complete registration of births than was realized in other recent years.

The downward trend in the birth rate has been due to several causes, among which the most important is the increased

² These rates are for the steadily expanding registration areas, but it is believed they are sufficiently representative of the entire country in the early years to be reasonably comparable with the rates for the more recent years, when the great majority of the states were included.

knowledge of birth control and its growing practice among the masses. Other factors of less influence are the rapid urbanization of the population and the economic stress of unfavorable business conditions on married couples. Although some of these influences are temporary, nevertheless, the trend in economic and social change is operating in favor of a continued decrease in the size of the American family.

In default of birth rates from 1900 to 1914, a measure of fertility may be found in the proportion of children under five years of age to 1,000 married women of normal child-bearing ages.

Table 2 shows a drastic decline in the proportion of children

TABLE 2
CHILDREN UNDER 5 PER 1,000 MARRIED WOMEN 15 TO 45 YEARS OF AGE

Year	All Classes	All Whites	Native White	Foreign-Born White	Negro
1900.....	929	908	870	1,054	1,083
1910.....	844	837	810	934	895
1920.....	772	779	742	931	702
1930.....	642	633	638	603	654

to married women of child-bearing age for each decade since 1900. Since it is known that infant mortality decreased between 1900 and 1930, and that in consequence the proportion of children born who lived to be five years old was greater in 1930 than in 1900, it is evident that the birth rate fell more rapidly than the above ratios of children. Apparently the birth rate in 1930 was not more than two-thirds of what it was in 1900 and the decrease during the last decade was greater than in any preceding ten-year period. Although the recorded population increase between 1920 and 1930 was 17,000,000, the number of children under five years of age at the later date was less than at the earlier one.

Table 2 shows that the proportion of white children to all white married women 15 to 45 years of age declined by 30 per

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cent from 1900 to 1930, while the corresponding ratio for the negro race declined by 40 per cent. But between 1920 and 1930, the proportion among whites fell three times as fast as that among negroes. This disproportionate fall in white fertility is probably connected with the decline of immigration since the World War.

The comparative fertility of foreign-born and of native whites is another problem upon which the proportion of children to married women throws light. But it encounters the difficulty of a large number of mixed marriages in respect of which the number of children with a native mother is unknown prior to 1930. According to the 1930 census, which reported this information for the first time, two-thirds of the children of mixed parentage had a native-white mother and this ratio was used in estimating the corresponding numbers at preceding censuses. The ratios shown in Table 2 imply that foreign-born wives were 21 per cent more fertile than native wives in 1900, while in 1930 the latter class had a fertility six per cent higher than the foreign-born. But the two groups of native-white and foreign-born white wives differ markedly in age composition, and these variations in age structure are much more important than other differences. Table 3 shows how widely the two groups differ in this respect.

TABLE 3
PERCENTAGE DISTRIBUTION OF NATIVE-WHITE AND FOREIGN-BORN WHITE WIVES
15 TO 45 YEARS OF AGE BY AGE GROUPS: 1900 AND 1930

Age Group	Native White		Foreign-Born White	
	1900	1930	1900	1930
15-19.....	4.4	4.2	1.8	0.7
20-24.....	17.8	16.9	11.8	6.9
25-29.....	22.8	21.3	20.4	16.2
30-34.....	20.9	21.0	23.6	21.9
35-44.....	34.2	36.6	42.4	54.3
15-44.....	100.0	100.0	100.0	100.0

Of the native wives 42.4 per cent, but of the foreign-born only 23.8 per cent, were less than 30 years of age in 1930. Since the fertility of women is greatest at about the age of 20 and decreases to a vanishing point at about the age of 50, this wide difference in the age structure of the two population groups must have affected the gross figures of comparative fertility. Moreover, according to the specific birth rates by age groups for these two nativity classes in the b.r.a. 1930, the fertility of foreign-born wives at each age period was distinctly higher than that of native wives, although the difference decreased as the age increased. Table 3 also indicates that the changes in the proportions by age groups for the foreign-born class between 1900 and 1930 were considerable, with the decline in the proportion under 30 years of age amounting to 30 per cent for the foreign-born, as against only six per cent for the native whites.

The influence of the differences in age composition of the two nativity classes in 1930, apart from all other factors, can be measured by assuming that each age group in each nativity had the same fertility rate as for all white wives, and by computing how many children on that assumption would have been born among 1,000 wives of each nativity class distributed to age groups, as shown in Table 3. The computed births among 1,000 native wives would have exceeded by 40 per cent those among 1,000 foreign-born wives, the wide difference being due solely to the variation in age structure of the two groups. It thus appears that for purposes of comparison the proportion of children to foreign-born wives in 1930 should be raised by 40 per cent from 603 to 844, a figure about one-third larger than the 638 children to 1,000 native white wives, as shown in Table 2.

The sharp decrease in immigration, the resultant rapid rise in the average age of the foreign-born by more than seven years between 1910 and 1930, and the fall in the birth rate

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among the foreign-born of each age group (tending to bring this rate into line with that among the native whites of like age) have combined to reduce rapidly the proportion of white children born of foreign parents and to increase correspondingly the proportion born of native parents. In the b.r.a. 1932 the latter class amounted to 82 per cent of all white births, so it seems safe to conclude that fully five-sixths of the white children born in the United States are of native parentage on both sides. If to these be added one-half of those of mixed parentage, fully seven-eighths of the blood in the white children born in recent years is native.

The statistics show that the birth rate is lower and has declined faster in urban than in rural communities. Formerly families having four or five children were common even in the cities, but now the more common number of children is one or two. One reason for the reduction in cities is that the cost of raising children in the cities is usually two or three times higher than in the country. In American cities of over 100,000 population, there are now only about two-thirds enough births to maintain their populations permanently stationary without accessions from outside. In cities of 2,500 to 100,000, the corresponding deficit is put at 10 to 20 per cent. But in the rural non-farm population, there is about a 25 per cent surplus in births over deaths, and in the farm population nearly a 50 per cent excess. As long as immigration is rigidly restricted, the cities will depend upon gains from the farms and villages to prevent their population from declining.

The deficit of births in cities is found principally among the so-called middle and upper classes. Class differential fertility—too little reproduction by the upper classes and too much by the lower classes—has been a characteristic phenomenon of American life. In general, families of professional classes have five to 10 per cent fewer children than those of business men, business men about 25 per cent fewer than

skilled workmen, and skilled workmen 30 per cent fewer than unskilled laborers. The extent or degree of the differentials in fertility between occupational classes in this country has decreased somewhat in recent years, probably due to the increasing spread of birth control knowledge among population groups less fortunate socially and economically.

TRUE RATE OF NATURAL INCREASE

The rapid decline in the national birth rate has brought it down to a level hardly sufficient to maintain a stationary population with our present expectation of life, provided there is no gain through immigration. But even this low birth rate is considerably higher than it would be except for our very favorable age distribution. Although we are in the habit of taking the age composition of our population for granted as if it were fixed by natural law, actually the proportion of persons at the different ages of life is not fixed but is variable. In fact, the distribution prevailing at a particular time is an important influence in many situations in the economic and social life of a country.

During the past census decade, our population had a disproportionately large percentage of people at the reproductive ages. This condition resulted first from the very heavy immigration of 25 to 35 years ago. These aliens were predominately young people who either brought young children with them or bore children soon after their arrival, and most of these children are now in the child-bearing ages. There is also a second factor, namely, the high birth rates which prevailed among the native stock a generation ago. This fact likewise contributed to a larger proportion of people now 25 to 35 years old than would have resulted if the present birth rate had prevailed in the previous generation. Both the heavy immigration and the earlier high birth rates have had the effect of swelling the proportion of those in the middle registers of

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life, and this in turn results in more births than the present fertility of the population would produce without the temporary circumstances of the concentration of lives at the young child-bearing ages.

With the passage of time this temporary bulge in the age distribution will tend to become smoothed out, and the population will then be entirely dependent upon the balance between the existing fertility and mortality unaided by any accidental irregularities in the age distribution. This change will inevitably be accompanied by a further decline in the number of births and an increase in the death rate. In fact, the age composition of the population in 1930 shows that as a nation we are moving toward a marked reduction in the proportion of young people and a corresponding increase in the percentage of old persons.

It has been reasonably well established that native whites and city dwellers have lower rates of natural increase than the other classes of population; and since we are tending toward a larger proportion of native white stock and of urban population, we may reasonably consider that these changes will contribute to a slower rate of growth, independent of other factors.

IMPLICATIONS OF REDUCED POPULATION GROWTH

The United States is approaching, in view of the continually diminishing rate of population growth, a situation in which the population may for a while become relatively stationary. Important social and economic consequences are likely to follow from the decline of the nation's numerical growth to a point of negligible gain. This country has become accustomed to a continually increasing population and consequently has the viewpoint and habits of an expanding nation. When it comes to the end of its population growth, however, the elasticity provided by a constantly increasing population and the expansion in markets consequent thereto will disappear.

Business men must gradually readjust their programs of production to meet the changing demands of a shifting age distribution. They will also be compelled to regulate production in conformity with any effect resulting from the slackening rate of increase in population during the next generation. This may be difficult because industrial and merchandising men have grown up and have operated for the most part in an atmosphere of rapid expansion. However, it is entirely possible that the slackening rate of increase of consumers may be offset by the broadening demand for goods, especially if the decline in population growth is accompanied by a tendency for the standard of living to improve. While expenditures for necessities may not greatly change, expenditures for cultural progress should increase considerably.

The time when the population will reach a point of virtual stabilization is of the utmost importance to agriculture, particularly with reference to the future need for farm land, since the number of people which constitute the domestic market very largely influences the consumption of farm commodities, especially food products for which the demand is relatively inelastic. The slower growth of population is also practically certain to affect the constantly increasing intensiveness of the use of land for residential and business purposes in and about our large cities.

SUMMARY

The birth rate in the United States has been declining very rapidly and is now only two-thirds as high as it was twenty years ago. In fact, the birth rate is hardly sufficient to maintain permanently a population as large as at present, although the great number of young adults who will not die for many years, the heritage of a higher birth rate and heavier immigration in the past, will result in a slow increase in population for perhaps 20 to 25 years more.

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The tendency of the past twenty years toward lower birth rates has decreased the proportion of children and has increased the average age of the population. This tendency toward an increase of older and a decrease of younger persons will become more marked with each decade. In fact, it is characteristic of a slowly growing population to have relatively few children but many old people.

The conclusion cannot be avoided that voluntary control in one form or another is the major factor in the rapid decline in the birth rate. One or two children per family, apparently, is considered enough by many parents, particularly those living in cities. But it is estimated that approximately three births per mother are required to maintain even a stationary population, as many children die in infancy, and a few more die before reaching marriageable age, while about 15 per cent of the adults never marry.

Furthermore, in view of the established facts that urban birth rates are lower than rural rates, that foreign-born white women are more fertile than the native-born, and that birth rates of women 20 to 29 years of age are higher than of those at older ages, it follows as a logical consequence that the increase in the proportion of persons living under urban conditions and the decrease in the proportion of married women 15 to 45 years of age who are foreign-born or who are 20 to 29 has contributed materially to the sizeable decline in the national birth rate during recent years.

Accompanying this drop in the birth rate has been a very gradual decline in the death rate, due largely to a marked reduction in infant mortality. But it is expected that, due to the advancing average age of the population, the death rate will slowly increase for a number of years until either the present bulge in the age distribution disappears or the span of life increases materially.

The advancing average age of the people and the increasing

proportion of the native-white stock in the total population should contribute rather heavily to a broader and better market for goods and services, and these developments might conceivably more than offset the declining numerical growth. Moreover, since a larger proportion of future urban gains will come from rural sources than in the past, due to greatly reduced foreign immigration and the fact that the native-white urban population is not replacing itself, there should develop a wider range and variety of common interests between the cities and the country and consequently there should arise an even greater need for intercommunication.

R. L. TOMBLEN

Notes on Recent Occurrences

"A FUGUE IN CYCLES AND BELS"

TO be connected with the telephone industry implies to most people a considerable familiarity with the technique of transmission. For those telephone people who aspire to talk—and think—intelligently on what their art is doing for and to the older art of music, a new volume by John Mills, "A Fugue in Cycles and Bels" (D. Van Nostrand Co., New York), offers both instruction and entertainment. Mr. Mills, who is Director of Publication of Bell Telephone Laboratories, has seen the frontiers of speech move westward from Denver to San Francisco, then eastward to Paris and London, and step by step onward until the globe has been encircled. During the same twenty years, that other frontier—telephonic quality—has been advanced until the music of a full orchestra can be transmitted with entire fidelity. It is the latter field which he surveys in his recent book.

At the end of Mr. Mills' lively account of Pythagoras, Galileo, Mersenne and Helmholtz, one feels that he has some acquaintance with the relationship between pitch and frequency. By easy steps, Chapter 2 takes the reader through elementary notions of the ear, the voice, complex vibrations and the telephone transmitter. Subsequent chapters deal with scales of pitch and loudness, with amplifiers, microphones, loud speakers and with the Laboratories' researches in audition. Other chapters on the power of music, on noise, on overloading and distortion and on auditorium acoustics lead up to the achievement of the reproduction of music in auditory perspective and what that feat, performed two years ago, may mean to music of the future.

Mr. Mills has wisely grouped all tables and graphs at the end

of the volume. This section forms a useful compendium of information on frequencies, decibels, response curves, energy levels and the like.

The engineer will find "A Fugue in Cycles and Bels" easy to read and a source of data not always available. The musician who aspires to be something more than an instrumentalist cannot afford to neglect an acquaintance with the physical bases of his art which this book will give.

